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MONTENEGRO
GOOD LOCAL GOVERNANCE

GIS MANUAL OF PRACTICE

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Prepared by

Jason Bates
Drago Djacic
Gretchen Mikeska

The Urban Institute

THE URBAN INSTITUTE
2100 M Street, NW
Washington, DC 20037
(202) 833-7200
www.urban.org

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1. OVERVIEW OF GIS TECHNOLOGIES

1.1 NARRATIVE AND OVERVIEW

In the last 10 years, a new form of technology has been appearing in both public and private sector businesses, such as waste disposal companies, airports, waterworks, and police departments. This technology is helping to improve billing and collections, customer tracking, quality control, and even made for more effective advertising. This technology is Geographical Information Systems, otherwise known as GIS technologies.

GIS technology consists of four main components, and requires multiple implementation projects. The components of GIS are highly accurate maps of a given area, high power viewing software, a trained GIS technician, and powerful enough computers to quickly and efficiently allow technicians to extract necessary data information related to GIS. Each one of these four components is vital to accurately and effectively using GIS technology. In the following section we will take an in-depth look at each of the vital components.

- **Implementing GIS technologies requires accurate base maps.** A base map is a digital image of a given area scanned into a computer and converted into a file format that GIS viewing software can understand and alter. The accuracy of these maps is what gives GIS its great power. With accurate base maps, you can create a model of an entire city right on your desktop computer; including maps of water pipes, electrical lines, waste collection sites, and almost anything else.

- **GIS requires accurate and powerful viewing software.** Although there are several good GIS viewing programs on the market today, there is one family of products that has become the world standard for GIS viewing; that is the MapInfo family of products. There are many benefits to MapInfo: ease of use, a quick learning curve, and interchangeability with other types of software, thanks to an "Open GIS" format. The ability of MapInfo to adapt itself to a large array of tasks makes it a very powerful tool for any user, whether they are brand new to GIS technology or the most experienced of veterans. MapInfo is also the most commonly used software in current GIS programs in the world today.

- **GIS technologies require a high powered viewing system.** Due to the complexity of the software and the size of the files used, GIS technology requires high speed computers, with the latest technology in visual display. If the speed of the computer is neglected in the set up of a GIS project, the end result will be slow and difficult to use, making it ineffective. Although investing in a high speed computer is a relatively expensive proposal, the time and energy saved with the investment are exponentially worthwhile. Another technological requirement of GIS technologies is a plotter printer. Plotter printers are used for the printing of layered base-maps for detailed viewing of wide areas in large scale.

- **The most important component of GIS technology is the human factor.** GIS technologies are nothing more than expensive toys without a technician who is properly trained in the use of all components of GIS. A good technician is invaluable to the company for which he works. A properly trained GIS technician can spot trends in product flows, track customers who are late on billing cycles, and spot potential problems in service before they happen.

The steps to implementing GIS technologies are also complex; they require many man hours and a highly organized approach. If there is even a slight deviance from the basic outline of the plan, the whole program can collapse. What follows is a basic outline of the steps involved in implementing a successful GIS program.

- **Before implementing GIS, the Champions must decide the overall goals.** There are several uses for GIS applications, each just as beneficial as the other. However, different uses require different steps in implementation. Different data sources, combined with different data collection methods are used to produce different results. To achieve the desired results of GIS applications, the first step is to decide what results are required.

- **GIS technology may also require some data records that are not in existence at the beginning of an implementation plan.** In this case, data will need to be gathered, prioritized, and converted into an acceptable format. This process can be time consuming and confusing. To properly gather data, there is a very concise process that must be followed for the newly created information to work well with the GIS system.

- **After all necessary data has been collected and organized; someone must input it into an organized database that is compliant with MapInfo standards**. Though not as complex as some of the other steps, this process is very time consuming and requires great accuracy. An inaccurate database will produce inaccurate information displays in MapInfo. In other words, the program is only as effective as the data used to run it.

GIS technologies can become complex very quickly. This is why it is important to follow a very specific set of guidelines when attempting to implement GIS technologies. In the following manual we will give a step by step process, which, when followed correctly, will lead to the successful creation of a GIS application. *Each step in this manual, no matter how small or trivial it may seem, is just as important as the rest, and no step should be neglected or underestimated.* It is also recommended that a Subject Matter Expert be consulted in the beginning phases of any GIS implementation plan, to identify any special requirements or circumstances related to the specific goals of the GIS program.

1.2 Participation Requirements for GIS Implementation Sites

As stated in the previous section, the implementation of a GIS program can be both time consuming and demanding on the resources of any organization. The following points will further outline the requirements of any organization wishing to implement GIS technologies into their everyday practices.

- **The organization must be prepared to dedicate a large amount of resources to a GIS implementation plan**. Man-hours for the implementation of an adequate GIS application will number in the hundreds. There is also the man-hour cost of maintenance and upkeep of the data systems involved in making a successful GIS program. Finally, one must consider that the data involved in a GIS program is constantly changing; this means that the continual dedication of human resources is required to keep the program systems accurate and effective.

- **Additional Data will need to be collected.** If there are missing pieces of data, then parts of the GIS application will be incomplete. This means that someone must collect or modify the data. GIS applications require precise geographic coordinates for the mapping and tracking of customers, equipment, and resources. The collection of such data requires work crews in the field collecting this data by hand, recording it precisely, and then bringing it back to a central location for entry into a database that is compatible with MapInfo standards. The larger the area being surveyed, the more man-hours are required to complete this process.

- **Data maintenance and upkeep are an ongoing process, no matter how many hours are invested**. Customer records, for example, are ever changing; people move, houses are torn down and rebuilt, and new buildings come on a yearly basis. To keep up with this process, there needs to be constant surveying, data tracking, and updates to data. This process requires a technician who is not only knowledgeable about the area he or she is in charge of tracking, but also the technologies involved in mapping that area.

- **Costs involved with implementing GIS technologies do not end when the implementation plan is completed.** As mentioned earlier, the upkeep of a GIS program requires a highly trained technician, who must work with the program for as long as it is active. The cost of new geographic surveys and constant updating of GIS-related data are necessary to receive continual benefit from the GIS program; after all, an inaccurate GIS system is worth very little. Finally, there is the upkeep of hardware; computers need to be replaced, printers run out of ink, and GPS applications needs to be updated and maintained.

All of the above mentioned costs are factors that must be strongly considered before undertaking a GIS program. It is a common misconception that once the initial project is complete, one may just sit back and reap the rewards of all of the hard work. However, this is far from the truth. Along with a great deal of effort in the original implementation process, there is just as much work involved with the upkeep and maintenance of a good GIS application.

1.3 Immediate and Long Term Benefits of GIS

The implementation of a properly designed GIS program will bring many benefits with it, both long and short term. While many of the benefits associated with GIS programs do not begin to become apparent until well into the implementation phase, there are also many benefits that will become apparent from the beginning of the program; some within the first week. The following section will outline both the long term and short term benefits of implementing and maintaining a GIS program.

- **Implementing GIS requires a precise survey of an organization's resources.** GIS software does not come with an individual organization's information pre-installed; this means a detailed survey of all resources. The benefits of such a survey include: up-to-date knowledge of all resources, their physical condition and location, and an awareness of previously unknown entities. For example, a waterworks completing a survey of their valves and water meters can reduce their technical losses by up to %20 by simply repairing damages found during the course of the survey.

- **The installation of a GIS program requires the updating of customer records and other databases.** Another immediate benefit of implementing a GIS program is the requirement of precise, up-to-date databases. For a GIS program to work properly, it must have current records on the customers and the equipment it is meant to track. In many cases, this will mean reorganizing, and in some cases, rewriting the databases used to store the required information to make them efficient and completely accurate. Accurate databases lead to better billing and collection efficiency, more accurate resource tracking, and improved customer service.

- **GIS programs mean the ability to accurately track resources, customers, and vital services.** Once the GIS program is implemented, it will allow an organization to track customers, resources, service records, and even spending trends by region and time of year. For example, a company can track the amount of money spent by their customers, compare it relationally to other offices, and even track what time of year its customers spend the most.

- **GIS can improve maintenance and reduce costs.** With up-to-date records of resources and previously performed maintenance, an organization can use GIS to improve the way it maintains its resources. An organization can use GIS to track areas that have required multiple maintenance visits, keep track of scheduled maintenance visits, and reassign maintenance personnel to work more effectively.

A properly implemented GIS program can produce these results and many more. If data can be stored and organized into a database, it can be viewed and modified by MapInfo software.

1.4 IS GIS THE RIGHT STEP, RIGHT NOW?

Beginning a GIS program means dedicating resources to a project that will not immediately begin to show a full return on effort. There are certain factors that any organization must consider before deciding to implement a GIS program. The following are questions that should be asked when contemplating the introduction of GIS technologies:

- **What is the cost benefit of having this information?** Any business installing a GIS program must first define the benefit expectations. If there are clearly defined goals and objectives that are set - based on realistic expectations of the technologies involved - then it can be a very effective step in improving many sectors of a company.

- **Are the resources available right now to undertake an implementation plan of this magnitude?** The implementation of GIS technologies is a time and resource consuming process. Therefore, the beginning of such a process must be weighed heavily when considering available resources. If a GIS implementation plan is started without enough available resources, it can quickly fail, resulting in a loss of not only financial resources, but also in lost time that could have been dedicated to other projects. Any organization wishing to implement a GIS program must be careful not to underestimate the demands of such a project.

- **How will this information be used once it is obtained?** If a large investment is made into technology that cannot be effectively used, it is a worthless investment. Before ever beginning a GIS program, the organization must consider the EXACT uses expected to come from GIS technologies. These uses must be considered against the cost of implementing the system. The full benefits of a GIS program are not realized if the collected data is not used to its full potential. Companies must develop a realistic idea of what data the GIS program can produce for them and how that data will be used in an effective manner.

After all of the above questions have been answered in a satisfactory manner, then there is only one more question to be asked: Where do we begin? The next step is to select a representative of the organization that will be able to learn all aspects of the GIS program and manage the implementation of the new technology. The next section of the manual will outline this process thoroughly.

1.5 SELECTION OF A GIS "CHAMPION"

GIS technologies can be very complicated and complex. It is very important to select a member of the staff, or "Champion", who can oversee the installation and utilization of a GIS program. The following is an outline of the responsibilities that will be required of the selected GIS Champion.

- **The Champion will be responsible for overseeing projects such as the selection of data sources, oversight of data collection, and conversion of data into MapInfo formats.** The method of collection of data is crucial due to the accuracy requirements and the overall complexity of the process. The Champion will be responsible for the overall management from within the water works for the implementation of the GIS program. The Champion will also be the link between the involved organization and any outside project management.

- **The GIS Champion will be responsible for project oversight.** After the implementation, it will be the responsibility of the GIS Champion to make sure that the GIS program expands continuously and stays up-to-date. This will involve tasks such as learning to use MapInfo, understanding the databases used to power GIS applications, and managing the continuous updating of information. The Champion will be in charge of problem resolution, resource scheduling, training of employees, and data validation.

- **Implementation of GIS systems requires many dedicated man hours.** A GIS Champion will need to dedicate all of his time to implementing and maintaining the primary GIS system. It is recommended that the GIS Champion be promoted to the position from within the organization. A Champion promoted from within the organization has knowledge of the environment and the staff's abilities; whereas a newly hired Champion will be faced with two learning curves, that of the GIS implementation plan, and learning the intricacies of the organization.

It should be noted that the newly selected GIS Champion does not need to be an expert in technology, just someone who is willing to learn, and take a pro-active approach to maintaining and expanding the system.

1.6 PARTICIPATION AND OVERSIGHT FROM OUTSIDE SOURCES

Due to its complexity, the implementation of GIS technologies will most likely require outside assistance from a trained expert. This expert will provide guidance and oversight to the exact process involved with the implementation of GIS technologies, as well as address individual problems that may arise during the implementation process. The following is an outline of a GIS Subject Matter Expert's responsibilities to the organization that employs him.

- **The GIS Subject Matter Expert will be responsible for educating the organization.** A GIS Subject Matter Expert should provide a general outline of the implementation process, as well as the upkeep and maintenance of a GIS program, educating all involved parties of the complexities and intricacies of such an implementation plan.

- **The GIS Subject Matter Expert will oversee all implementation efforts.** The Subject Matter Expert will provide oversight for the organization from the first phases of implementation all the way through the training of the GIS Champion. The Subject Matter Expert will also work closely with the Champion throughout the implementation plan, teaching them the intricacies of GIS programs.

- **The Subject Matter Expert will provide project management assistance.** As well as oversight of the project, the Subject Matter Expert will assist the Champion in setting deadlines, outlining landmark accomplishments, and addressing individual problems that may arise in the implementation process.

- **The Subject Matter Expert will provide training to the GIS Champion.** As well as assisting in the implementation process and helping with individualized problem solving, the GIS Subject Matter Expert will provide hands-on training to the selected representative of the water works in not only MapInfo software, but also database maintenance and the process for further collecting and utilizing new data.

The real importance of a GIS Subject Matter Expert is project management and training. GIS technologies implementation is a very complex and time consuming process. Without proper project management and task tracking, unnecessary time and resources will be spent needlessly. Without proper training, the newly implemented GIS program will sit idly by, not making a return on the investment required to attain it.

1.7 MAN HOUR REQUIREMENT WORKSHEET

The following worksheet will assist in gaining a general overview of the total number of man hours necessary to implement a full GIS program. Though this will not be an exact number, it is very important to have a realistic view of how long such a project can take. To complete the worksheet, simply fill in the blank variables and complete the computations as directed.

A- Manholes

The formula for determining man hours to conduct an accurate survey of man holes is as follows:

$$\frac{\textit{\# of manholes to be surveyed}}{\textit{\# of crews conducting survey}} * .3 = \textit{Man hours required to survey manholes}$$

B- Water meters

The formula for determining man hours to conduct an accurate survey of water meters is as follows:

$$\frac{\textit{\# of meters to be surveyed}}{\textit{\# of crews conducting survey}} * .3 = \textit{Man hours required to survey water meters}$$

C- Customers

The formula for determining man hours required to conduct an accurate survey of customers is as follows:

$$\frac{\textit{\# of customers to be surveyed}}{\textit{\# of crews conducting survey}} * .15 = \textit{Man hours required to survey customers}$$

D- Pipes

The formula for determining the man hours required to conduct an accurate survey of pipes in a given area is as follows:

$$\frac{\textit{\# of KM of pipe to be surveyed}}{\textit{\# of crews conducting survey}} * 2.5 = \textit{Man hours required to survey pipes}$$

E- Data Entry

The formula for determining the man hours required for the entry of data is as follows:

$$\frac{\text{\# of fields of data}}{\text{\# of employees entering data}} = X \qquad \frac{X}{50} = \text{Man hours required to enter necessary data}$$

F- Total Man Hour Calculation

The formula for calculating overall required man hour investment is as follows:

A + B + C + D + E = Total Man hour requirement

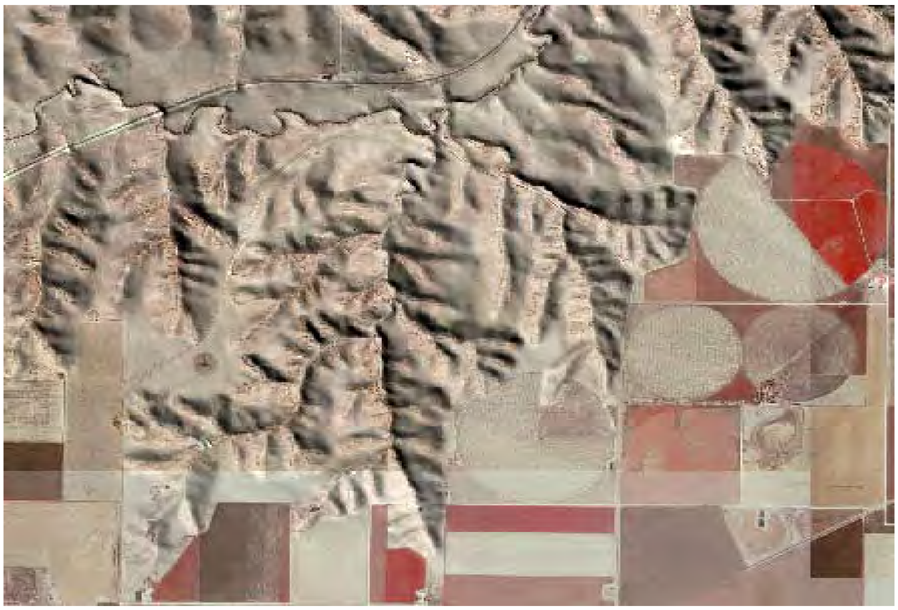
1.8 Landmark and Deliverables for Criteria Selection

The following is a short list of deliverables and landmarks that should be accomplished as the first step towards implementing a new GIS program. Upon completion of each of the following deliverables, it will be time to move on to the second chapter of this manual.

1. Thoroughly reading the first chapter of the GIS implementation manual
2. Selection of a GIS Champion to represent the waterworks
3. Consultation with GIS Subject Matter Expert on necessary hardware and software for implementation of GIS program
4. Completion of Goal determination worksheet
5. Selection of criteria for GIS needs
6. Coordination of project implementation with GIS Subject Matter Expert
7. Completion of man hour requirement worksheet
8. Attainment of all necessary hardware and software

MANUAL OF PRACTICE
CHAPTER TWO

DEFINITION OF NECESSARY DATA SOURCES FOR IMPLEMENTATION



2. DEFINITION OF NECESSARY DATA SOURCES FOR INTEGRATION

2.1 IMPORTANCE OF OPTIMAL DATA SELECTION - NARRATIVE AND OVERVIEW

GIS is a dynamic process of collecting, processing, and utilizing data. A successful implementation of GIS involves large amounts of data. Since GIS deals with large amount of data, optimal data should be selected and processed. GIS implementation should be well planned, prepared, and carried out by a technical department, with assistance of a GIS Subject Matter Expert.

If data is not well selected, documented, converted into logical databases and complete information procedures, or not updated on a regular basis, they will become less valuable. The following is an outline of requirements for data processing.

- **The data processing mode must be automated and standardized as much as possible.** Errors occur more frequently on the human level than on the mechanical level. Therefore, automation of the input process is crucial. This process involves the creation of "macros" in databases, which allow data to be automatically converted from numeric format into database format. Another application designed to reduce the human error factor is a "thematic chart". This will allow the GIS Champion a quick visual check for errors of all information entered.

- **The source of data must be defined.** There are several data requirements for a complete GIS implementation. There are multiple sources available for acquisition of necessary data; however, the two main sources are the data sources already owned by the organization, and those owned by public institutions. Public institutions consist of government offices, census bureaus, postal offices, and data tracking organizations.

- **Data collection must be broken down into phases.** The collection of data for a GIS program is a large undertaking for any organization. To simplify the process as much as possible, it must be broken down into a step-by-step outline. These steps will include integration of maps, input of pre-existing data, collection of field data, input of collected data, and collection and input of data from public institutions.

2.2 DATA PROCESSING METHODS

The precision and success of a GIS implementation depends on the method of data input and data processing. If a manual mode of data input prevails over automation, a significant number of errors can occur. In order to minimize the possibility of an error, all data possessed by the organization (whether in analogue, digital, numeric, or graphic form) will go through the process of data input and data processing with maximum use of automation application software.

An error within GIS data usually occurs during manual data input performed by a human operator.

The process of data input can be split into the following three categories:

- **Data processed by the GIS Subject Matter Expert.** This group of data will be integrated into the system and converted to correspond to GIS by a trained technician. It will include plans, maps, and various databases. An error WILL NOT occur during input or processing of this group of data, since everything will be performed automatically.

- **Data input performed by GIS Champion.** The GIS Champion, after a short training, will input graphic entities with the necessary minimum of numeric data. This is the most demanding part of the process, and the occurrence of an error is highly possible and even expected.

  The following two activities will help eliminate errors, enabling maximum data coexistence:

  ☑ Usage of "thematic charts" (a tool which filters and processes data and gives a visual picture) which enables the administrator to spot and eliminate errors.

  ☑ Consultation with a GIS Subject Matter Expert. While using GIS, experienced technical professionals can point out errors to be checked or corrected.

- **Automated input and processing of data.** Part of the data collected in the field is collected by means of a GPS (*Global Positioning System*) device, or geodetic total stations, designed for automatic recording and data storage. Input; or more precisely, transfer of these data to computer is performed by means of application software. The further processing of this input data is completely automatic which means no possibility for an error.

The features of GIS as a powerful system for providing any kind of information, linked with its compatibility with other application software, have reduced the need for manual data input to approximately 10% of all data needed for operation. This greatly reduces the possibility of an error in data processing.

All data processing, no matter who performs the process, is carried out completely on a GIS platform, which excludes possibility of a software conflict error.

2.3 SOURCES OF NECESSARY DATA

There are two main sources of data which are necessary for the successful implementation of a GIS program. In order to provide starting minimum function and utilization of a GIS program, two components are needed:

- **Well-planned and well-formed structural system analysis**. This analysis defines structures for database and data flow during the process of data input. This involves processing and utilization of data, with obligatory anticipation of system upgrading and addition of new data that is not currently available.

- **Plans with appropriate ratios are necessary.** These plans must be taken from analogue and digital format, converted, and geo-coded.

The necessary data for GIS implementation are grouped into two groups, according to their origin:

☑ *Data owned by public institutions*

☑ *Data owned by water works*

- **DATA OWNED BY PUBLIC INSTITUTIONS**

Digital and Analog Maps

Plans with the ratio of 1:500, 1:1000 and 1:2500 are the basic cadastre level maps. 1:5000 maps are designed, updated, and in possession of the *Department for Real Estate for the Republic of Montenegro*.

The maps with the ratio 1:25000 are in possession of *Military Geographical Institute*. Organizations need maps with the ratio 1:25000 and 1:5000, and plans with Vertical presentation with the ratio 1:500, 1:1000, or 1:2500, depending on the survey ratio of the given territory.

Planning Documentation

The Department for Urbanism in municipalities is responsible for designing and preparing planning documentation, as well as for governing the process of its acquisition. It is obligatory that plans on development and extension of any physical system should be in compliance with planning documentation. Planned extensions must be in compliance with predicted traffic routes, then in hydraulic calculation predicted, population must be considered etc.

Population Survey Information

The data gathered in population surveys is important for organizations. Its utilization, after processing in GIS, provides faster and more efficient customer service, and presents basic information for planning and organizational development. The data on numbers of population and households, cattle, and data on customers of organizations is also important. The institution in charge of conducting population surveys, data processing, and executing their utilization is *The Institute for Statistics "MONSTAT"*.

- **Data on Real Estate Owners**

  Another important piece of information for organizations is the name of the owner of real estate, land, object or apartment. GIS also provides spatial locating of real estate by any database keyword in case of a damage report or request for issuing a license for a new service.

  Existing databases are usually not in compliance with accurate data on ownership, which often causes failure when court interference is required with bill collection. The institution in charge of updating and utilization of data on real estate owners is *SCG Office for Real Estates*.

- **Company Related Data**

  The Department for Economy in municipalities is in charge of updating data on companies. This data includes major occupation, manager, main office, period of existence, etc. It happens very often in organizations that product consumption is charged according to a lower pricing scale as a result of inconsistency between company related data and billing database, which causes major financial loss. Up-to-date company related data can help to address this issue.

- **Street Names**

  Quick location of billing sites is possible if sites are identified and labeled by accurate street names. Accurate street names also enable spatial research by billing location as a keyword, thus street names allow data analysis and filtering.

  Data possessed by public institutions must be updated on a regular basis. Keeping in mind that many government offices and local institutions have not implemented GIS, and that data changes are introduced on a daily basis that do not significantly affect optimization of GIS utilization, it is sufficient to update data within the following time intervals:

  - ☑ Once a month for company related data;
  - ☑ Every six (6) months for data on property owners;
  - ☑ After street renaming;
  - ☑ After approval for planning documentation; and
  - ☑ After population survey.

The greatest advantage of GIS is a compact, open, and standardized system in which recently updated data is exchanged within an organization.

- **DATA OWNED BY THE ORGANIZATION**

Sources of available data within an organization include "material" data, in

analogue or digital form, and employed technical professionals.

Since the foundation of an organization's numerous data have usually been collected in various forms, (e.g. data on resources, sources, technical data, and customer records, and so on) all of these data sources are valuable, but not efficiently used. To make these data sources useful, they must be systematized, filtered, and converted to GIS format. Thus, processed and stored data will offer simple and quick access and utilization for all of the organization's employees. Experienced technical professionals employed in the organization to maintain and control systems over the years are a source of valuable information that has not been put on paper.

2.4 PHASES OF DATA IMPLEMENTATION

Data for GIS implementations are organized by priority, so that each new phase requires implementation of the following steps:

- **Integration of digital and analog maps**

  In order to satisfy a minimum of functionality; that is, to enable input of other types of data, it is first necessary to acquire and "build in" maps and plans into the system.

- **Input of data by GIS Champion**

  After an initial training of the Champion, input of data owned by the organization should begin immediately. This will help to define the amount of work to be done in the field.

- **Collection of data from the field**

  This phase of the implementation marks the start of data collection in the field. The amount and type of data will be determined after analyzing data from the second phase, as well as agreements reached between the GIS expert and the organization's management. Since the GIS Champion has begun his training, he will begin daily processing of data collected in the field, start data input, and input graphical entities provided by various public institutions.

- **Rationalization of data**

  The final step is the rationalization of numeric data provided by public institutions and their linking to corresponding graphic entities. This will require the information that was updated and processed in the third phase by the GIS expert.

2.5 Landmarks and Deliverables Checklist for Data Source Selection Process

The following is a checklist that can be used to measure completion of the previous chapter:

1. Review of chapter two: Data Selection Process
2. Completion of data source selection matrix
3. Selection of necessary, secondary, and useful data sources
4. Acquisition of necessary data sources from outside organizations
5. Acquisition of secondary data sources from outside organizations
6. Acquisition of all internal data sources
7. Approval of quality of data sources by GIS Subject Matter Expert

2.6 DATA SOURCE SELECTION MATRIX

The following Data Source Matrix can be used to gain a visual perspective of what data sources are available and necessary for the implementation of the GIS program. To complete the matrix, fill in the data sources column, then place an X in the appropriate box in the corresponding row.

DATA SOURCE SELECTION MATRIX

Data Source	Critical for Implemantation	Helpful for Implementation	Not Necessary for Implementation	Available Immediately	Must be Acquired	Public Sector Information	Private Sector Information

MANUAL OF PRACTICE
CHAPTER THREE

RATIONALIZATION OF DATA SOURCES

3. RATIONALIZATION OF DATA SOURCES

3.1 IMPORTANCE OF DATA ACCURACY – NARRATIVE AND OVERVIEW

Managers and technical professionals of organizations must operate with accurate and up-to-date data in order to eliminate possible errors in the system operation, and continually consider possible solutions and upgrades. In cases where data is inaccurate or outdated, the approach for damages and malfunctions is usually incorrect and inadequate, and can result in far-reaching consequences.

The process of updating and standardization is called *rationalization*. If access to data is not provided quickly, solutions to problems will be late, which can result in financial loss. In addition to data accuracy, daily maintenance and operative management require constant data source updating and unity. Good data rationalization and updating give the user quick and easy access to data and the ability to reach decisions on any related problem.

The most demanding part of GIS is data collection in the field. This process is time consuming, expensive, labor intensive, and depends on factors such as the weather. Data collection in the field, however, quickly brings benefit to any organization, which immediately eliminates dilemmas concerning the relevance of GIS implementation. The following is an outline of what can be achieved with data collection from the field:

- **Data on resources for which there is no documentation are collected**. Many organizations do not have a detailed database of their resources. The process of data collection from the field will produce an information structure of all resources, giving the organization great managerial oversight abilities.

- **Data on technical structures already implemented in GIS by the administrator are checked and updated**. This process gives the organization an ability to double-check existing information on resources.

- **Location of billing sites is drawn on field sketches, and the code in the existing billing database is also introduced into the sketch**. This will give the organization an overview of all customers and potential revenues in their customer base.

- **The Benefits of Spatial location and geo-coding of water meters.**

  - ✓ Spatial analysis of charged merchandise is performed.
  - ✓ Visual survey of billing sites to be replaced is conducted.
  - ✓ Determination of an individual code for each customer.
  - ✓ Spatial distribution by zones of consumption for desired time period.
  - ✓ Visual survey of billing sites and comparison with parcels to make sure each customer is registered.

3.2 RATIONALIZATION AND REDEFINITION OF THE EXISTING BILLING DATABASE

Existing billing databases are not updated in many organizations, so it will be very useful and purposeful to include into each field crew a member who performs billing site readings and collects money in the specified area.

During work in the field, the following types of data will be rationalized:

- ✓ Data on customers/owners of connections;
- ✓ Pricing scale by which a customer is charged;
- ✓ Whether or not a customer has connection to the organization;
- ✓ Data on billing sites – technical specifications as well as relevant data; and

✓ Listings of illegal connections.

It is clear that the work on data collection in the field, checking, and rationalization relates to data that the organization has. Rationalization and filtering of data received by public institutions is performed during their input and processing, which will be explained in detail in the next unit.

It is very important to emphasize that during work in the field, all illegal clientele will be discovered, as well as damages and irregularities to the system. It is important for organizations to standardize the format for the reporting of illegal connections, in order to disconnect them and pursue collection alternatives.

If organizations respond quickly to damage reports by field crew and repair damage, it is estimated that resource loss will be reduced substantially and all visible loss can be eliminated.

3.3 DATA CONVERSION AND RATIONALIZATION

Data owned by public institutions are important for GIS implementation, and will be redefined during input, linking, and processing, depending on their form and structure. Taking into consideration the structure and form of data owned by public institutions, this manual will state phases, steps, and obligations to follow in order to implement them in GIS.

- **Municipal Plans and Maps.** If plans exist in analog format, after scanning, all deformations will be removed and they will be geo-coded into MapInfo by the GIS Subject Matter Expert. Digital plans in DWG format will be converted by the Champion with prior training given by the GIS Subject Matter Expert.

- **Planning documentation.** The Champion and previously trained waterworks employees will draw required graphic entities and input values in the following created attributes of databases:

    - Borders of separate planning zones (corresponding graphic entity- region)
    - Planned trajectories of physical resources (graphic entity-line)
    - Borders of planning zones with defined purpose (graphic entity-region)
    - Planned traffic lines
    - End points of traffic lines with corresponding vertical measures are put into EXCEL databases, followed by charting and construction of elements in AutoCAD and finally conversion to MapInfo.

The process of implementation of planned traffic lines into GIS will be performed by the Champion, with the assistance of the GIS expert.

- **Population survey data.** *The Institute for Statistics (or "MONSTAT")* updates population survey data in two incompatible formats. The first is the graphic part which is processed in analogue form; this includes the definition of where there are borders of survey circles and statistics circles. The other is the numeric portion, which is defined in an *MS ACCESS* database. It is the Champion's obligation to draw borders of survey circles with corresponding graphic entity-region, and link them to numeric database with the assistance of the GIS Subject Matter Expert. After linking, it is necessary to check drawn borders of survey circles comparing them to the numeric part of the database, which will be done by the Champion and the GIS Subject Matter Expert.

- **Data on property owners.** It is desirable that the GIS Subject Matter Expert performs complete input of data into GIS of real estate owners because of the requirement for a high level of knowledge in information technology. If there is a professional capable of performing this process within the organization, then it is desirable that they perform the process.

  The Department for Real Estates updates data on real estates in two incompatible formats; cadastre plans which are in digital DWG format and data on owners in a tabular format in textual files.

  If procedures of data input are not completely respected and the structure of attributes is not clearly defined in the process of data input into textual file, errors can occur. These errors should be eliminated before linking with graphic entities.

Linking of a graphic entity and number of cadastre parcels with a numeric database will be performed after introducing the number of cadastre parcels from the cadastre plan into the database with the aid of GIS tools. The following information should be entered into the corresponding databases:

- **Corporation related data**. It was noted in chapter two that these data are important for updating the billing database and determining pricing scales for all customers. The organization's crews should locate companies, mark them by points on chart, and input the following attributes:
  - ✓ Company name
  - ✓ Main office address
  - ✓ Telephone number
  - ✓ Contact person

- ✓ Legal representative
- ✓ Code in company register
- ✓ Tax-on-extra-profit number
- ✓ Orientation and occupation
- ✓ Company owner
- ✓ Owner's address

- **Street names.** Lines in GIS represent streets; their names and width are introduced into a database. GIS tools convert a line into a region of width stated by the value retrieved from database.

- **House numbers.** A new layer will be formed from the cadastre plans. Through a process of filtering and line combining, one will create graphic entities as regions. Regions represent individual houses, separate entrances of buildings, and companies to which database attributes are assigned as street names and house numbers. Thus, implementing house numbers into GIS presents
- A powerful information platform which can be used by hospitals, police departments, courts of law, post offices, power supply companies, etc.

3.4 WORK PLAN FOR COLLECTION OF DATA

The following is a work schedule for phases of rationalization and redefinition of data owned by the organization. The most evident need for data redefinition in the organization is the billing database.

- **Preparation and implementation of database of real estate owners in GIS**. This involves collecting data from statistical organizations as well as customer records and billing records, and entry into a compliant database.

- **Preparations for field work**. This includes separation of billing databases by region for reading and financial collection, and separation of databases of real estate owners by cadastre regions and plans.

- **Individualized training for employees.** Since data on resources will be checked and updated simultaneously with revision and update of the billing database, it is necessary to conduct a short training session for workers who collect data on how to put information into databases. The aim of the training is to clearly define what type of data should be collected and updated, and what samples and patterns they must be put into, along with which format.

- **Process of data input.** Data input concerning rationalization of the billing database is performed in two locations: 1) billing locations are spatially located in GIS and, 2) the customer code is put into the billing database.

3.5 Landmarks and Deliverables for Data Rationalization Process

1. Review of chapter three
2. Creation of data rationalization matrix
3. Selection of data sources where the rationalization process is applicable
4. Training of GIS Champion in rationalization process
5. Application of rationalization process to all individual databases

3.6 Data Source Rationalization Matrix

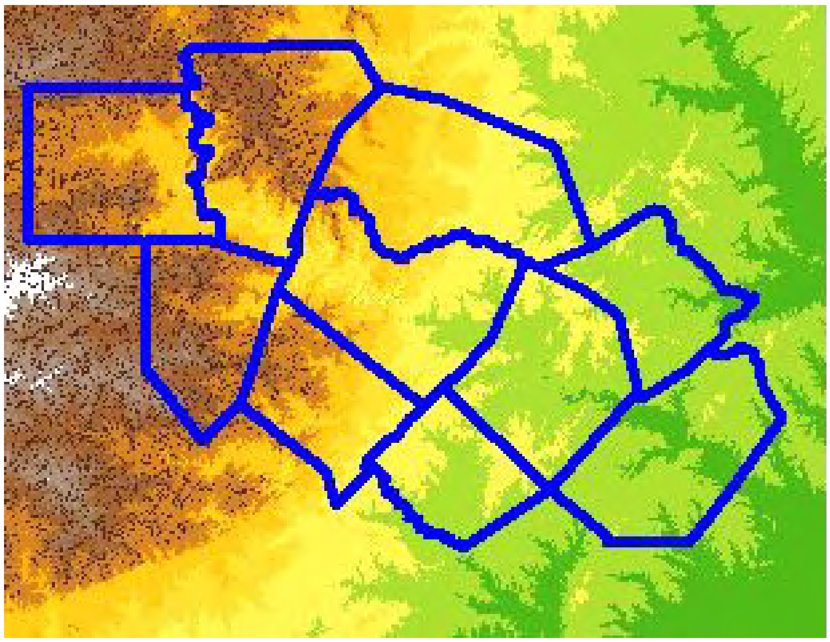
This matrix can be used to gain a visual perspective of available data sources for implementation into the GIS program. To complete the matrix, fill in the available data sources in the left hand column, and place an x in the appropriate column for each data source.

Data Source Rationalization Matrix

Data Source	Up-To-Date	Needs Minor Updating	Needs Major Updating	Non-existent	Internally created	Externally created	DBMS format

MANUAL OF PRACTICE
CHAPTER FOUR

COLLECTION AND INPUT OF DATA



4. COLLECTION AND INPUT OF DATA

4.1 OVERVIEW OF COLLECTION AND INPUT OF DATA

The collection and input of data is perhaps the most time consuming part of the implementation of a GIS program. This process involves a full physical survey of not only all of an organization's customers, but also its resources and equipment. The collection of necessary data, in most cases, will involve a field survey of all of an organization's general resources, including its customers. Inputting this data means taking all of the collected information and organizing and entering it into a compliant database. The following section will give a general overview of the process of collecting and inputting data.

- **All necessary data that is not readily available must be collected prior to the use of GIS software.** In many cases, the data required to create an accurate GIS program is non-existent at the beginning of a GIS implementation. If this is the case, the data must be collected before any of the GIS viewing software can be used. Often, this will mean a full survey of not only the customer base, but also resources and equipment. For example, a water works company wishing to implement GIS technologies must first survey all water meters, pipes, reservoirs, field equipment, and customers before they can begin using the GIS software.

- **There is a defined process for the collection of data.** The process of data collection must be definitive and repeatable. If a method of practice is not implemented in the data collection process, it may lead to redundant steps or missed information. Before any data is collected, the implementer must define a strict method of collection based on a set of standards defining the process.

- **The necessary data for the implementation must be outlined precisely.** For surveyors to effectively collect information, they must have a clearly defined standard of what information is necessary. To define this standard, an organization must first define what data will be necessary for the GIS program. This definition is usually a uniform set of databases; however, the individual organization must customize the information used to best suit their needs.

- **Inputting data should be automated whenever possible.** Even the best employees can make mistakes, and when entering multiple lines of data, the chances for human error increase. This is why the process of inputting data should be made as automated as possible. There are simple formulations that can be entered into most database programs, called “macros”, which can automate the transfer of collected data.

- **Unnecessary data must be removed.** In some cases there will be fields in available databases that are unnecessary. When this is the case, the organization must remove these fields to avoid clutter and confusion when the GIS implementation is complete. Unnecessary data will also slow search and display times when accessing data from within the databases in GIS viewing software.

- **The process of data collection and input must be highly organized.** The process of collecting and inputting data must be organized down to a daily basis. There must be daily goals and requirements set forward for the survey crew. There must also be requirements set for the time allowed to pass before collected data is input into the appropriate databases.

The primary focus of the collection and input phase of a GIS implementation must be efficiency and accuracy. If data collection is not highly organized, it will take longer than necessary and expend more resources than necessary. If accuracy is sacrificed for speed, then the information will be inaccurate and ineffective. The following section will outline how to combine accuracy and efficiency to make the data collection and input process efficient and cost effective.

4.2 PROCESSES INVOLVED IN DATA COLLECTION

In the previous chapters of the manual, necessary data has been pinpointed and the processes and phases of implementation that need to be executed have been explained. This unit of the manual will cover phases of data collection in the field, referring to data structure and data format required for input into MapInfo software.

The most efficient and precise method of collecting data in the field is to collect data in previously defined regions. These regions can be bordered by natural borders (rivers, streets, etc), delivery zones, or even territorial boundaries; however, the most efficient boundaries are billing zones.

Billing zones are optimal areas in terms of size for data collection and control of data input. The process of data collection and data input in GIS requires control and thorough checking at several intervals throughout the process. With the usage of billing zones as pre-defined boundaries, it is expected that data audits should be performed after surveying each individual billing zone. Another advantage of this division by billing zones is that more surveying crews can be engaged simultaneously.

The following is an outline of the steps and equipment required for a complete data collection process. The steps have been arranged by priority and location in the data collection process.

- **Step One: Provision of necessary data**

  An outline of necessary data to be provided in advance from the organization and external organizations was provided in Chapter Two: *Definition of Necessary Data Sources for Implementation*. Before work can begin, all required data sources must be obtained.

- **Step Two: Creation of Data Collection Kits**

  Prior to the beginning of the collection process, all data collection employees must be properly equipped. This will include the provision of all plans, sketches, templates, and lists needed for data collection in the field. The data collection kit should include each of the following: (See Technical Annex 1)

- ☑ Cadastre plans with ratio 1:1000, on paper format A3, including cadastre parcels' numbers, sheet markings, and denotations of water works and sewer pipes (if they have been put into plans from existing waterworks documentation). Plans should be printed without shadings of objects and in black ink so that more space is available for inscriptions and sketching of field objects.

Annex A1: Plan 1:1000

Synoptic sketches on A3 format paper with a ratio of 1:1000 which should include: (See Technical Annex 1)

- ☑ Grid of plan sheets with a ratio of 1:1000 with markings
- ☑ Borders of cadastre regions
- ☑ Borders of billing zones

Annex A2: 1:10,000 Plan Sketches

Synoptic sketches on A3 format paper with a ratio of 1:10,000, which should include: (See Technical Annex 1)

- ☑ Grid of plan sheets with a ratio of 1:10000 with markings
- ☑ Borders of cadastre regions
- ☑ Borders of billing zones

Annex A3: List of Real Estate Owners

Database on real estate owners should be printed out by cadastre regions, bound in a small notebook, with following attributes included: (See Technical Annex 1)

- ☑ Number of cadastre parcel
- ☑ Owner's first and last name
- ☑ Registry number

Annex A4: List of Customers

A Billing database (list of customers) should be printed out by cadastre regions, bound in a small notebook, with following attributes included: (See Technical Annex 1)

- ☑ Customer's name
- ☑ Customer's code
- ☑ Metering number
- ☑ Metering technical specifications
- ☑ Extra Services
- ☑ Payment Type

Annex A5: Template for Unregistered Customers

Template for introducing data on unregistered customers (See Technical Annex 1)

- ☑ The template should have all relevant data as the template for registered customers, and used to create a legitimate customer record for all previously unregistered customers. (See Technical Annex 1)

Annex A6: Template for Diagramming Equipment

Template for acquisition and sketching of data on manholes includes: (See Technical Annex 1)

- ☑ Number of billing zone
- ☑ Serial number of equipment
- ☑ Technical dimensions and outlines

After sketching technical diagrams and inscription of dimensions, one should inscribe labels of standardized fittings and technical fittings, as well as the code of the equipment beside their symbols in the template.

It is very important that all technical data is measured and recorded accurately; inaccurate data creates an inaccurate system.

Annex A7: Template for sketching and recording chamber data

Template for acquisition and sketching of data on inspection chambers includes: (See Technical Annex 1)

- ☑ Number of billing zone
- ☑ Number of equipment inspection site
- ☑ Technical dimensions of equipment

After sketching base and cross-section, the data collection crew must inscribe diameter and material of pipes, as well as obligatory direction of the flow.

It is very important that distance between inspection chamber's cover and manhole interior walls is measured and inscribed into sketches.

Annex A8: Template for sketching atmospheric sewerage inspection chambers

Template for acquisition and sketching of data on atmospheric sewerage inspection chambers includes: (See Technical Annex 1)

- ☑ Number of billing zone
- ☑ Number of atmospheric sewerage inspection chamber
- ☑ Depth from the top of cover down to the bottom of atmospheric sewerage pipe

After sketching base and cross-section, data collection crews must inscribe both the diameters and materials for each of the pipes. **It is very important that**

distance between inspection chamber's cover and manhole interior walls is measured and inscribed into sketches.

- **Annex A9: Template for sketching washout basins**

  Template for acquisition and sketching of data on wash out basins includes: (See Technical Annex 1)

  - ☑ Number of billing zone
  - ☑ Number of wash out basins
  - ☑ Depth from the top of grate down to the bottom of pipe
  - ☑ Number of bars in a grate

  After sketching the washout basin's cross-section, the data collection crew must inscribe the diameter and material of all pipes.

- **Step Three – Employee Training**

  Since the updating of billing databases is performed simultaneously with updating of data on equipment in the field, it is necessary to organize a series of short training sessions for all of the employees that are to perform data collection in the field. The training should include training on the proper process for inputting data into databases, and the overall maintenance of these databases. The training will also include the procedures of data updating, GPS unit operation, and digital camera operation. The goal of the training will be to clearly define what type of data should be collected and updated, as well as what templates it should be put into, including style, format, appropriate software, etc.

- **Step Four – Data Collection in the Field**

  Now that the initial assembly of data, training of personnel, and preparation of information is complete, the process of data collection may begin. As with the rest of the implementation, this must be an organized methodical process. Data collection employees must be organized into crews and proper equipment must be provided. The following is an outline of the necessary crew structure, and equipment that must be provided to each crew.

  Ideal Field crew structure:

  - ☑ 1 Technician, crew leader
  - ☑ 1 Technician for data updating
  - ☑ 1 Physical laborer
  - ☑ 1 Collection agent

  Needed equipment for data collection in the field:

  - ☑ leveling staff for measuring depth of manholes
  - ☑ Meter with up to 5 m length

- ☑ Tools for cover opening (pickaxe, hammer weighing 3 kg, bar, shovel, and hooks made for manually lifting cover)
- ☑ Meter with up to 20 m length
- ☑ Digital camera
- ☑ Manual GPS
- ☑ Aluminum battery lamp
- ☑ Manual laser length measuring tool with length range up to 20m

Tasks and obligations of crewmembers:

Crew leader:

- ☑ Coordinates activities of all crew members
- ☑ Draws and inscribes following information in plans:
  - ✐ Draws waterworks manholes, inspection chambers, then ascribes numbers to them and inscribes them in sketches. Also introduces point numbers from GPS in case location is surveyed by GPS.
  - ✐ Denotes water meter location and inscribes its code from water meter database.
  - ✐ Interconnects manholes and inspection chambers and inscribes material and diameter of pipes.
  - ✐ Inscribes data on illegal unregistered customers in the corresponding template.

Technician:

- ☑ Sketches in templates manhole equipment, fittings, and standardized fittings, and inscribes their labels.
- ☑ With the help of physical worker determines dimensions of manholes, position of manhole cover and pipeline in reference to interior walls, and position of pipeline. In reference to manhole cover; inscribes dimensions in templates. If needed, manhole base and cross-section is sketched.
- ☑ Sketches inspection chambers and washout basins and inscribes attributes defined in templates (depth from the top of cover/grate down to the bottom of pipe, diameter and material of pipe)
- ☑ Takes photographs of manholes
- ☑ Performs GPS recording
- ☑ Checks on data in list of customers and records possible changes

Billing Agent:

- ☑ Locates water meter for each customer from lists of customers in the field and determines its code in billing database
- ☑ Performs his ordinary activities - takes readings and collects money.

The total number of manholes and inspection chambers must be consistent in plans and sketches with numbers of photographs and GPS points. For this reason the crew leader must pay special attention to assigned numbers, and have an in-depth knowledge of the waterworks system. All employees assigned to the data collection teams must be competent in their individual fields and possess the ability to learn complex tasks quickly, and repeat them numerous times with minimal errors.

4.3 INPUTTING DATA INTO MAPINFO COMPLIANT DATABASES

After each day of data collection, the data collected must be input into the appropriate databases to maintain a highly organized information system. Each day of data collection requires inputting data and updating, since irregular input can make already collected data unclear, and create a need for re-collection.

It is also necessary to check collected and inputted data for each region after the data collection process has been completed there; and to withhold the process of new data collection in the following region until possible mistakes and inconsistencies from the primary location area have been removed.

Data collected in the field are sent to five locations, depending on the authorization for their input and utilization:

- ☑ Information on objects, digital photos, and GPS points are sent to GIS software and databases;
- ☑ Data on customers is sent to the billing database;
- ☑ Detected irregular entities are sent to survey departments;
- ☑ Detected and noted damages to the appropriate damage repairing service.; and
- ☑ Customers who do not pay their bills regularly are referred the legal department, which will take adequate measures to collect past due payments.

Data from the field is input in two formats. The first is manually entered data, where an automatic input format is unavailable. The other type of format is an automatic input format. The decision to input data manually or automatically must be made depending on the structure and format of the collected data. The following is an outline for the determination of the need for manual or automatic input.

Automated data input:

- Digital photos are transferred to computer by means of Universal Serial Bus (USB) communication software and coding, numbers are assigned to them as file names and they are stored in a predefined directory. If there are multiple photos for one manhole they should be merged into one file with the help of the appropriate software and file management systems.

- GPS data is transferred to a computer by means of software. A file is transferred in this way by using a macro (a specially designed conversion formula) which converts data into a format that is automatically charted into GIS software.

Manual data input:

- Manholes, inspection chambers, and washout basins not recorded with GPS are located and assigned numbers are put into database.
- Pipelines are drawn and data from pipeline database are inscribed.
- Water meters are spatially located and drawn into sketches; only customer code is inscribed into database.
- From sketches of manholes, inspection chambers and gully-holes data are inscribed into databases.

After manual and automatic data inputting practices are performed by GIS tools, other attributes in databases will be automatically filled in by a series of software created to simplify the input process, and remove human interaction with the software wherever possible.

4.4 Landmarks and Deliverables for Data Collection and Input Process

1. Completion of data collection matrix
2. Creation of data collection criteria
3. Creation of standardized data collection forms
4. Planning and implementation of automation process
5. Creation of a strategic plan for collection of data
6. Training of GIS Champion in data collection/input process
7. Commencement of data collection
8. Successful primary data input
9. Achievement of 25% collection/input of data
10. Achievement of 50% collection/input of data
11. Review of collected/inputted data and random verification of accuracy
12. Achievement of 75% collection/input of data
13. Achievement of 100% collection/input of data
14. Review of collected/inputted data and random verification of accuracy
15. Implementation of data into MapInfo

4.5 Data Collection Matrix

The following Matrix will assist you in determining the data collection needs for this process of the project. Input all data sources into the matrix, and fill in the appropriate boxes.

Data Collection Matrix	Data Already Exists	Data Exists Partially	Data Must Be Collected	Data Is Present Internally	Data Is From External Source	Collection Requires Survey Crew
Data Source						

MANUAL OF PRACTICE
CHAPTER FIVE

USAGE OF NEWLY ACQUIRED DATA

5. USAGE OF NEWLY ACQUIRED DATA

5.1 USAGE OF GIS DATA

Once the implementation process is complete, and the GIS technologies are fully ready to use, the next step is learning how to use them. There are almost unlimited uses for GIS technologies. If information can be organized and stored in a database, it can be viewed using GIS viewing software, GIS viewers can even be used to study the geography of the human brain. The following chapter will describe what the uses of a properly implemented GIS program are, and how to use GIS effectively.

- **GIS can be used to increase revenues within a company.** GIS technologies give organizations the ability to see information stored within a database in a digital map format. This means that organizations can track resources visually, and use GIS to spot trends in sales. For instance, a power supply company might use GIS technologies to obtain a visual reference of all of their power meters attached to customers.

- **GIS can improve billing and collection processes.** GIS technologies can be used to track payment regions for supplies. An organization can use GIS to rezone payment centers and restructure billing methods. For example, a water works company can use GIS to analyze its billing zones and adjust prices accordingly. GIS can also be used to spot “trouble areas” in the billing process. GIS technologies can be used to track areas of non-payment and spot trends in delinquency of payment.

- **GIS can improve maintenance and upkeep procedures.** GIS technologies can be used to track maintenance trends in an area over a period of time. GIS can also help to track scheduled maintenance of objects and equipment. When the proper information is entered in a proper format, GIS can be used to track time that has passed since an object’s last scheduled maintenance visit, and help predict the next visit. GIS can also give a visual representation of areas that have had unusually frequent or infrequent maintenance levels over a period of time. When used to its full potential, GIS will cut maintenance costs not only by ending unnecessary maintenance visits, but also by predicting where a problem will occur before it happens.

- **GIS improves customer service.** When all areas of a GIS program are being used to their full potential, they will improve the service of any organization. This means that the service to the customer will improve. There will be fewer losses of service due to unexpected problems, scheduled maintenance will be completed on time, and there will be a complete record of every customer in the organization’s database, allowing them to have accurate information about their customers on hand instantly.

The use of GIS technologies is almost limitless. Organizations regularly find new ways to implement GIS programs into their daily operations. In fact, many organizations rely heavily on the information obtained by their GIS programs to run both internal and external operations.

5.2 Outline of Individualized Uses for GIS Programs

Within the previously mentioned departments, and through the technological processes in which GIS can be used, one can fully understand the possibilities for the utilization of an information system of the kind in which modern technical achievements are implemented on a large scale. These achievements require a synchronized and permanent link between alphanumeric and graphic forms of data. Once the data has been collected, and the links between data have been established, the GIS program is ready to be utilized to its full potential. The following is an outline of how to fully utilize the newly implemented system.

- **Cadastre of waterworks and sewerage system**

  In conjunction with databases and graphic presentation of pipeline and objects powered by the appropriate viewing software, GIS presents a powerful system and utilization ability for a great number of users, in each of the following categories:

  - ☑ Enhanced information for everyday operative maintenance of the organization and all available assets with quick access to all data in the system.

  - ☑ GIS data are used as annexed documents (spatial distribution of objects and assets) in the process of stating conditions for and giving approval to projects and planning documentation.

  - ☑ Vital information to be considered for the addition of new billing locations based on GIS data (characteristics of terrain, network characteristics, connection spots, detailed presentation of utilities with equipment and material).

  - ☑ Spatial and numeric presentation of equipment including their type, category and amount, all relevant statistical data to the system needed for analyzing and planning.

- **Planning and development**

  Planning and development processes require precise data on current condition of physical systems. GIS data are used to aid these processes in the following ways:

  - ☑ GIS can be used in spatial distribution and development analysis of internal and external systems from the beginning plan drafts to the final plan version.

  - ☑ GIS can also be used in the process of preparing spatial, general and detailed plans, as well as presenting existing technical structures.

- **Compilation of Damages in Distribution Networks**

  Spatial distribution of repaired damages offers the ability to determine locations that incur persistent damages by viewing graphic representations of the area. GIS also enables an organization to investigate possible causes of damage without sending technicians to the site. A damages database is useful for visualization of the following:

  - ☑ Access to detailed records of materials and invested man hours as well as generalization of the necessary workforce for repairing damages.
  - ☑ Spatial analysis of repaired damages in the following categories: work crews, city zones, type of damages, equipment types, etc.
  - ☑ Detailed planning of necessary materials and equipment based on databases of spent material in the previous period.

- **Analysis of Consumption on a Regional basis of Previously Invoiced Products**

  The history of consumption by regions based on invoiced products is invaluable data in eliminating losses to an organization. Analysis of invoiced products by predefined consumption zones over a period of time presents singular valid data in making decisions and undertaking operative measures in the following activities:

  - ☑ Data can be used in the location of unknown network damages.
  - ☑ GIS can be used as primary point for the measuring of internal system parameters in order to detect damages.
  - ☑ Data can be used to determine the profile of future billing schematics and locations.
  - ☑ Data can be used to track lack of collection in specific areas, and determine causation for lack of collections.

- **Data Usage is Customizable to the Institutions Individual Needs.**

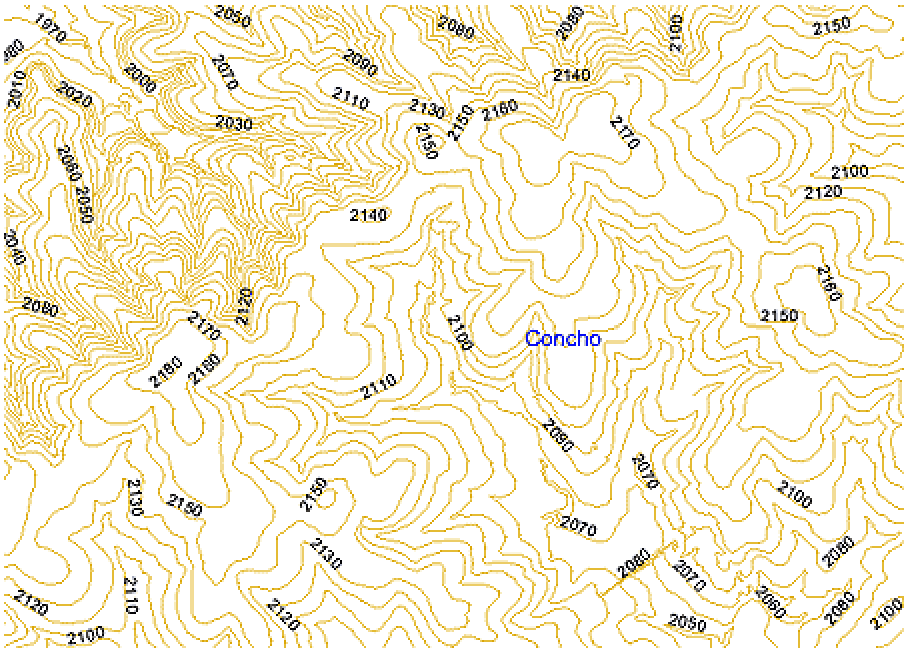
  Although the base data that is necessary to implement a successful GIS program is very similar, with an extra level of data collection, a GIS program can be custom tailored to meet the needs of any organization. The only limitation to the data that can be stored and viewed in GIS software is the imagination and creativity of those using the equipment.

5.3 Landmarks and Deliverables for Using GIS Technologies

1. Completion of matrix of applications for GIS technologies
2. Creation of criteria for use of GIS technology
3. Creation of application plan for implementing GIS technologies into every day functions.
4. Training of GIS Champion in all forms of GIS application
5. Utilization of GIS information in singular processes within the organization
6. Utilization of GIS information in complex processes within the organization
7. Utilization of GIS information for departmental operation.

MANUAL OF PRACTICE
CHAPTER SIX

TRAINING OF THE GIS CHAMPION



6. TRAINING OF A GIS CHAMPION

6.1 CHARACTERISTICS AND REQUIREMENTS OF A GIS CHAMPION

The most important part of the entire implementation process is selecting a member of the staff who will oversee not only the implementation of the GIS program, but also its upkeep and expansion. This GIS "Champion" will play a crucial role in both processes from the beginning of the implementation. The position of Champion should be a permanent one. The Champion will face many responsibilities and must be able to handle many technical problems, as well as management. The following chapter will outline the responsibilities of the GIS Champion as well as the requirements for their character.

- **The GIS Champion will manage a complex project.** Even after the initial implementation, GIS programs can be complex and require constant oversight; this will be the job of the Champion to organize. The Champion will have to manage updating, information tracking, and expansion of the program. This will require a dedication to the program and an ability think critically.

- **The GIS Champion will be responsible for extracting and analyzing data from the GIS viewing software.** The Champion will also have the responsibility of making the GIS data available to other sections of the waterworks, in a format that is understandable. Directly after the implementation, the Champion will be the highest trained GIS technician in the organization, and will therefore be the link for the rest of the organization to the GIS data. This will require not only an in-depth knowledge of the technologies being used, but also an in-depth knowledge of how the other departments of the organization work.

- **The Champion will be responsible for providing in-depth training to the other staff for the use of GIS viewing software.** Due to the complexity of the software in use, and the data collection methods employed, it is not possible to give in-depth training to multiple staff members. Because of this, it will be the responsibility of the Champion to select the necessary staff members for the continuation of the GIS program, and train them in the necessary tasks. This means that the Champion must be able to teach others the knowledge he has gained. Training of extra staff will be critical, since maintenance of the GIS program will need multiple employees.

- **The Champion will be in charge of the expansion of the program.** Once the initial implementation has been completed, the GIS program can begin its expansion process. Rarely can a complete GIS program be created in the primary implementation. In the expansion process, new forms of data will be collected, records will be continually updated, and the area covered by the GIS program will be expanded. Each step in the expansion process requires trained management in the process of implementing GIS data.

A well-trained Champion is a critical asset to any successful GIS program. The oversight and knowledge provided by a Champion are invaluable. A Champion must be willing to commit a large amount of time and energy to the GIS program, not only during the initial implementation, but also as long as he is in charge of oversight of the project. The Champion from any organization should be chosen for more than the technical abilities and knowledge of the processes in place within the organization. Factors such as motivation, teaching skills, project management, and ability to think broadly must also be considered very heavily.

6.2 OUTLINE OF LEARNING PROCESS FOR GIS CHAMPION

The most crucial sub-project in the implementation of a successful GIS program is the training of the GIS Champion. The GIS Champion will be responsible for the maintenance and oversight of the entire GIS program after the initial implementation. Therefore, the training process must be in-depth and complete. Without a properly trained Champion, a GIS program will not realize its full potential. The following section is an outline of the learning process involved with training a GIS Champion.

The Champion's training will be a multi-phase process. The Champion must be trained in not only the use of MapInfo software and the databases used to support it, but also the practices necessary to continually advance the GIS program. To achieve this level of knowledge, the Champion must be involved with the program of implementation from the beginning, allowing him to observe the process in its entirety. The training of the Champion consists of the following eight stage process:

- **Participation in overall planning stages.** The initial planning stages of a GIS implementation outline the specific measures that need to be undertaken for a successful implementation. The Champion's participation must begin at this point. This training will give the Champion training in project planning, as well as an overview of the steps necessary to collect and integrate data into the GIS.

- **Training for Rationalization of Data.** The Champion's participation in the process of rationalization of data will be crucial. In this stage of the implementation, the Champion will be in charge of oversight of the updating of databases and organization of information for future use in the GIS program.

- **Involvement in Data Collection Process.** During the process of data collection, the Champion must not only participate in the gathering of data from the field to gain knowledge of the necessary practices; he must also actively participate in the organization of the data collected for input into the appropriate databases.

- **Data Inputting Process.** The GIS Champion will be in charge of all data entry. This involves assisting in structuring the integrated databases, and inputting data into them. The Champion must also train fellow colleagues in the process of inputting data.

- **Training in the use of MapInfo Software.** Along with data collection and input, the Champion must simultaneously learn to use MapInfo software for completion of the next phase of the implementation: integration. This training process will require training to be provided by a GIS Subject Matter Expert.

- **Participation in the Process of Data Integration.** After all data has been collected and inputted into the necessary databases, the Champion will be trained in the process of integrating data from these databases into MapInfo software.

- **Training in the Maintenance of Data.** The process of data maintenance involves a combination of all of the prior training steps, plus training on the expansion and creation of new databases to retain new volumes of information. The Champion will be in charge of the upkeep of databases, as well as their continual expansion and organization.

- **Instruction in Program Expansion.** The initial implementation of a GIS program is just the beginning of the process. The GIS Champion must be trained to continue expanding the initial base provided in the implementation. The Champion must also be trained to train others, as they will be the link between GIS and their organization. This training will be a culmination of all the other training processes involved in the implementation.

After the initial training is complete, the GIS Champion will be the organization's link to the GIS program. Therefore, complete and thorough training is a requirement. If a step is neglected in the training program, deficiencies may begin to appear in the program. With a thorough training process, however, the GIS Champion can give his organization not only great managerial advantages, but financial benefit as well.

The Champion's training must not end with the completion of the initial implementation either. Technologies related to GIS are constantly evolving and improving. This means a continual learning curve for the Champion. MapInfo, for instance, releases new versions of their program on an annual basis; and the databases used to support MapInfo are in a continual process of upgrade and improvement as well. For a GIS Champion to be truly effective, he must not only know the software he is in charge of maintaining, but also stay aware of the improvements and advancements made in the field of GIS technology.

6.3 Landmarks and Deliverables for Training of a GIS Champion

1. Review of Chapter Six “Selection of a GIS Champion”
2. Creation of criteria list for GIS Champion
3. Creation of a primary selection list of candidates
4. Creation of Champion position within the organization
5. Selection of GIS Champion
6. Creation of job description for GIS Champion
7. Commencement of training of Champion
8. Commencement of data entry by Champion
9. Oversight of project by Champion

6.4 Training Plan Matrix for GIS Champion Training

This matrix gives a visual perspective of the Training requirements for the GIS Champion and secondary employees. It includes the ability to track the progress of the training throughout the implementation process.

GIS Champion Training Plan Matrix	GIS Champion	Secondary GIS Employees	Completed	In Progress	Not Started
GIS overall planning					
Data Rationalization					
Data Collection					
Data Input					
MapInfo Training					
Data Integration					
Data Maintenance					
Continued Program Expansion					

MANUAL OF PRACTICE
CHAPTER SEVEN

GLOSSARY OF TERMS
AND
TECHNICAL ANNEXES

7. GLOSSARY OF TERMS AND TECHNICAL ANNEXES

7.1 GLOSSARY OF TERMS

GIS: Geographical Information Systems

IMPLEMENTATION PLAN: The initial stages of planning for a GIS program and the effort to achieve it.

IMPLEMENTATION: The overall process of installing GIS and collecting data to power the system.

GIS PROGRAM: A fully functional GIS, complete with up-to-date databases, and accurate base maps, the result of a full GIS implementation.

GIS APPLICATIONS: GIS applications are programs and files that are employed to power a GIS program.

GIS SOFTWARE: Includes MapInfo or any other viewing software.

ORGANIZATION: Any business, either public or private.

GIS CHAMPION: Employee of the organization wishing to implement a GIS program who will be responsible for project management and oversight of the GIS implementation plan from within the organization.

GIS SUBJECT MATTER EXPERT: A Subject Matter Expert is a consultant with knowledge of GIS technologies and implementations, from outside of the organization wishing to implement a GIS program.

HARDWARE: Physical equipment, in this case, used to power a GIS. Hardware includes a high speed computer, small scale printer, as well as a large plotter printer.

MACRO: A specially written formula within a database to aid in the transfer and organization process of information.

ORGANIZATION: Any institution, public or private, in this case, with an interest in the GIS implementation process.

SOFTWARE: Computer programs used to power GIS. These include databases, viewer software, and digitization programs.

7.2 ANNEX 1--FIELD DATA COLLECTION MANUAL

The following annex is a basic field data collection manual to be carried by all crews participating in the survey process. This manual will fulfill the minimum requirements put forth by this manual for the data collection process. All regional and sectional maps should be printed as required for the daily collection process. One backup data copy of all applicable information should be kept in a secure location.

ANNEX A-1

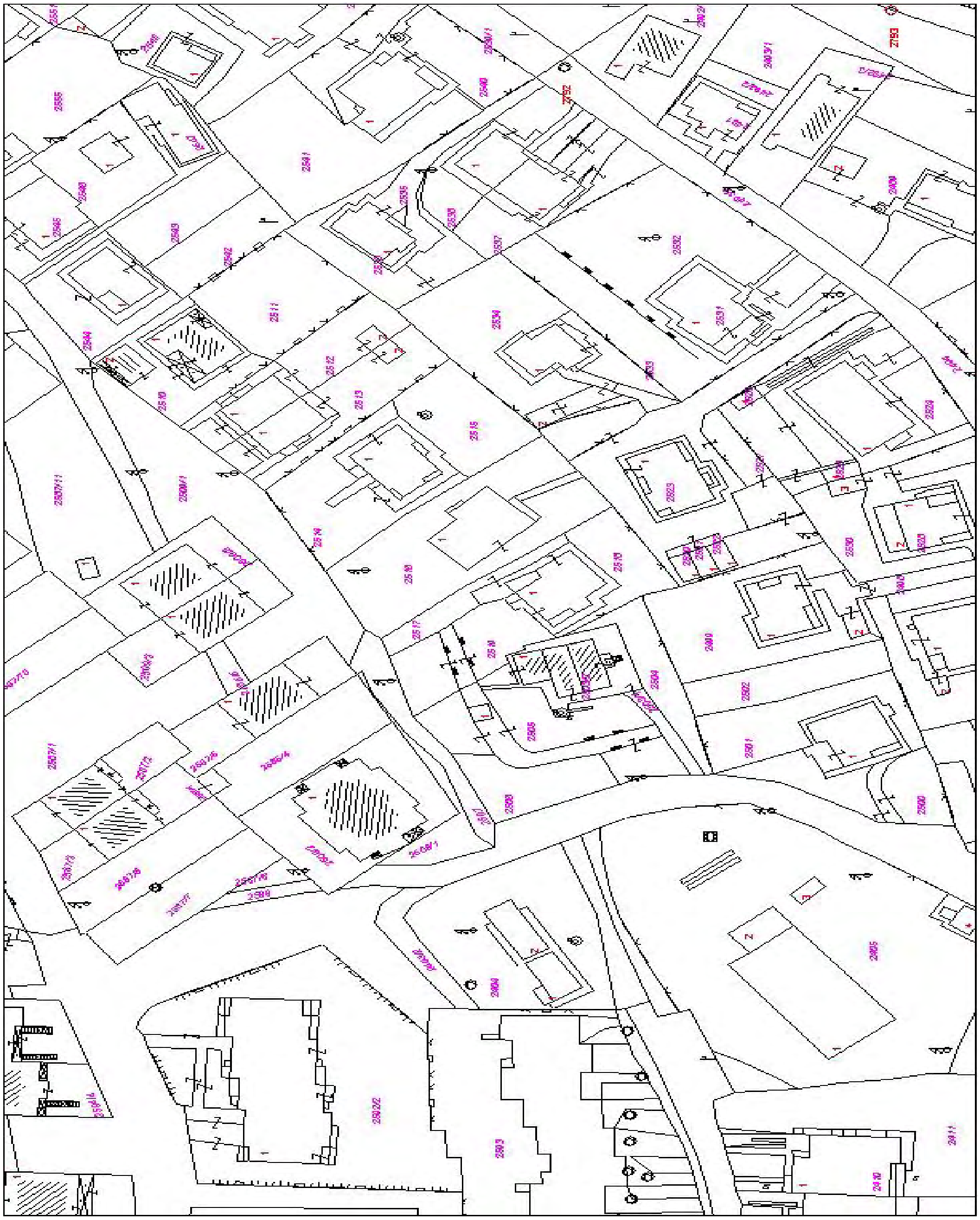


Diagram 1 – Cadastral Map with a ratio of 1:1000

ANNEX A-2

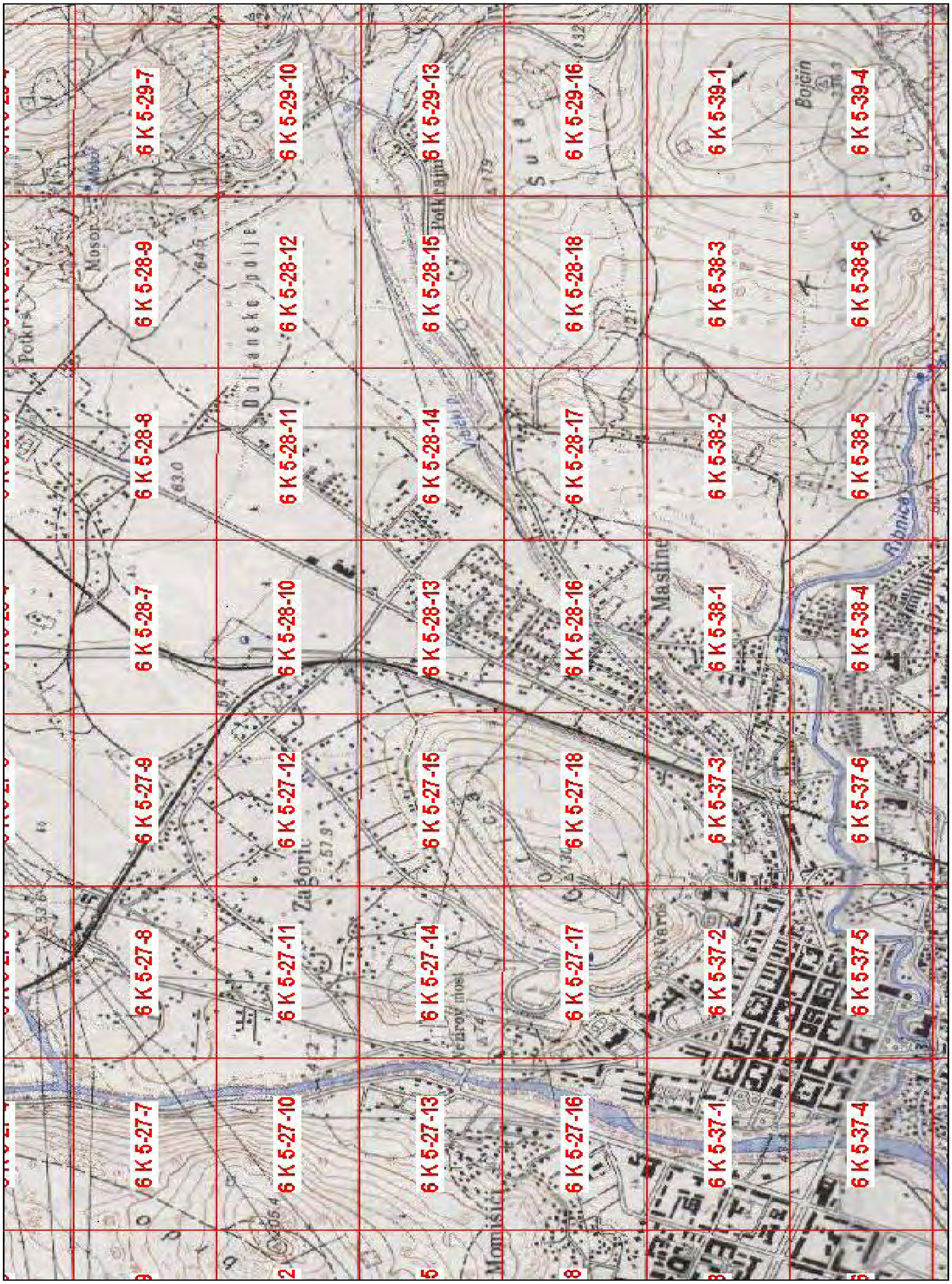


Diagram 2 – Cadastral Map with a scale of 1:10000, separated in to 5 KM x 5KM sectors

ANNEX A-3

Diagram 3 – Customer spread sheet with federal registration number

BROJ KP	IME I PREZIME	MATIČNI BROJ	
379	VUKČEVIĆ DJURO MILOŠ	2110925210010	
380	RADUNOVIĆ DJURO RADOMIR	1411951210033	
381	RADUNOVIĆ DJURO RADOMIR	1411951210033	
382	PETKOVIĆ SAVO MILORAD	1603935210062	
383	VLAHOVIĆ JOVIĆ BRANKO	1707947210254	
384	VLAHOVIĆ JOVIĆ BRANKO	1707947210254	
385	MIRANOVIĆ MILKA	9999999001588	
386	VUKČEVIĆ ĐIVKO BOĐIDAR	0601986210346	
387	VUKČEVIĆ ANKA UD. ĐIVKA	2403950215016	
388	VUKČEVIĆ PERO RADMILA	2303944215018	
389	VUKČEVIĆ PERO RADMILA	2303944215018	
390	VUKČEVIĆ PERO RADMILA	2303944215018	
391	VUKČEVIĆ PERO RADMILA	2303944215018	
392	RADUNOVIĆ DJURO RADOMIR	1411951210033	
393	VELJOVIĆ JOVAN ZORKA	1808946715221	
394	VELJOVIĆ JOVAN ZORKA	1808946715221	
395	VUKČEVIĆ PERO RADMILA	2303944215018	
396	VUKČEVIĆ PERO RADMILA	2303944215018	
397	PETKOVIĆ JOVAN SAVO	2402924210026	
398	LAZAREVIĆ RADOMIR VELIMIR	1410946171511	
399	LAZAREVIĆ RADOMIR VELIMIR	1410946171511	
400	VELJOVIĆ JOVAN ZORKA	1808946715221	
401	RADINOVIĆ ILIJA BOĐIDAR	2101950210034	
402	VUKČEVIĆ PERO RADMILA	2303944215018	
403	VUKČEVIĆ PERO RADMILA	2303944215018	
404	VUKČEVIĆ PERO RADMILA	2303944215018	
405	VUKČEVIĆ PERO RADMILA	2303944215018	
406	VUKČEVIĆ PERO RADMILA	2303944215018	
407	VUKČEVIĆ PERO RADMILA	2303944215018	
408	VUKČEVIĆ BRANKO DRAGAN	2006952210047	
409	VUKČEVIĆ BRANKO DRAGAN	2006952210047	
410	VUKČEVIĆ BRANKO DRAGAN	2006952210047	
411	VUKČEVIĆ RADOVAN VOJISLAV	9999999001277	
412	VUKČEVIĆ RADOVAN VOJISLAV	9999999001277	
413	VUKČEVIĆ RADOVAN VOJISLAV	9999999001277	
414	VUKČEVIĆ ĐARKO RADOVAN	9999999001958	
415	VUKČEVIĆ BOĐO JOVAN	9760112300125	
416	RAIČKOVIĆ JOVAN DANICA	1803945215029	

ANNEX A-4

RB	SIFRA	IME I PREZIME	ADRESA	KANAL	BR.VODOMJERA	PROFIL
1	301000100	VUČINIĆ BRANISLAV	VII OMLADINSKE 59	N	01211622	13/3
2	301000200	RADUNOVIĆ MILO	VII OMLADINSKE 39	N	00577930	20/3
3	301000300	RADUNOVIĆ STEVO	VII OMLADINSKE 41	N	01051412	13/3
4	301000500	STOJANOVIĆ IVO	VII OMLADINSKE 37	N	01270054	13/3
5	301000600	PAJOVIĆ BORO	VII OMLADINSKE 36	N	01107769	20/5
6	301000700	RONČEVIĆ VUKOTA	VII OMLADINSKE 35	N	00429631	20/5
7	301000800	RADUNOVIĆ IVAN	VII OMLADINSKE 33	N	02951162	13/3
8	301000900	RADOVIĆ VESELIN	VII OMLADINSKE 30	N	01800545	20/5
9	301001000	JOVANOVIĆ SRETEN	VII OMLADINSKE 30A	N	01047675	13/3
10	301001100	RADUNOVIĆ ĐIVORAD	VII OMLADINSKE 31	N	01234300	20/3
11	301001200	RADUNOVIĆ DRAGO	VII OMLADINSKE 33	N	01757347	20/3
12	301001300	RADUNOVIĆ VELIŠA	VII OMLADINSKE 25	N	01153327	20/5
13	301001400	BRNOVIĆ DRAGOLJUB	VII OMLADINSKE 23	N	01162092	20/5
14	301001500	TODOROVIĆ MILENKO	VII OMLADINSKE BB	N	00759671	20/5
15	301001600	PAJOVIĆ LJUBIŠA	VII OMLADINSKE 23 A	N	01183019	20/5
16	301001900	BRNOVIĆ VLADO	VII OMLADINSKE 21	N	00729569	13/3
17	301002000	\EKIĆ BRANKO	VII OMLADINSKE 21	N	01449994	20/5
18	301002100	RADUNOVIĆ VIDOJE	VII OMLADINSKE 23	N	01449561	20/5
19	301002200	RADUNOVIĆ VITOMIR	VII OMLADINSKE 23	N	01449794	20/5
20	301002300	RADUNOVIĆ PERO	VII OMLADINSKE BB	N	01735218	20/5
21	301002400	BRNOVIĆ MIHAILO	VII OMLADINSKE BB	N	00349760	20/3
22	301002500	BRNOVIĆ MILORAD	VII OMLADINSKE BB	N	02845505	20/3
23	301002600	KULJAK MILEVA	VII OMLADINSKE BB	N	01449952	20/5
24	301002700	ROVČANIN MILOICA	VII OMLADINSKE 20	N	00697488	20/5
25	301002800	RADUNOVIĆ MILOŠ	VII OMLADINSKE BB	N	01071936	13/3
26	301002900	RADUNOVIĆ PETRANA	VII OMLADINSKE 21	N	00624377	13/3
27	301003000	RADUNOVIĆ RADIVOJE	VII OMLADINSKE 22	N	00984051	20/3
28	301003100	RADUNOVIĆ LAZAR	VII OMLADINSKE 18	N	01071828	13/3
29	301003300	RADUNOVIĆ RAKO	VII OMLADINSKE 16	N	02019857	20/3
30	301003400	RADUNOVIĆ RISTO	VII OMLADINSKE BB	N	01151340	13/3
31	301003600	RAIČEVIĆ MILORAD/KAFANA/	P.KOMUNE BB	N	01663437	20/5
32	301003700	RADUNOVIĆ MILKA	VII OMLADINSKE 14	N	00390398	20/3
33	301003800	USKOKOVIĆ BOGIĆ	VII OMLADINSKE 19	N	01317937	13/3
34	301003900	KARADĐIĆ RADOMAN	VII OMLADINSKE 17	N	01060388	20/5
35	301004000	BRACOVIĆ NENAD	VII OMLADINSKE 13	N	01017872	20/5
36	301004100	JANKOVIĆ ILIJA	VII OMLADINSKE 11	N	00429631	20/5
37	301004200	BOLJEVIĆ MILKA	VII OMLADINSKE 12	N	01107723	20/5
38	301004300	BOLJEVIĆ PERO	VII OMLADINSKE 8	N	01071809	13/3
39	301004400	BOLJEVIĆ VOJO	VII OMLADINSKE 6	N	01271331	20/5

Diagram 4 – Customer data spreadsheet for methodic surveying of connections to the system

ANNEX A-5

RECORD OF UNREGISTERED CONNECTION AT BILLING LOCATION

CONTROL REGION _____________

1. **Property Owner** ____

   ____

   Property User____

   ____

2. **Adress (At point of measure)** ____
3. **Adress (of the consumer)** ____
4. **User Type** ____
5. **Type of Business** ____
6. **Number of Household Memebers** _____________________________________
7. **Customer Data:**

User Code_________________________________

Previous User Code:_______________ **New User Code:**__________________

Number of Water Meter : __________________ **Profile and Capacity :** ________

Type of Water Meter: ____

Water Meter Code: ____

Connection to the Sewerage System: YES NO ,

Water-Meter Status : MAIN INTERNAL

Water-Meter Sealed : YES NO

Current Water Meter Reading ________________**(m3)**

Date

_____________ **200__**

Diagram 5 – Unregistered connection recording sheet. Use this form to record all unregistered connections discovered during the survey process.

ANNEX A-6

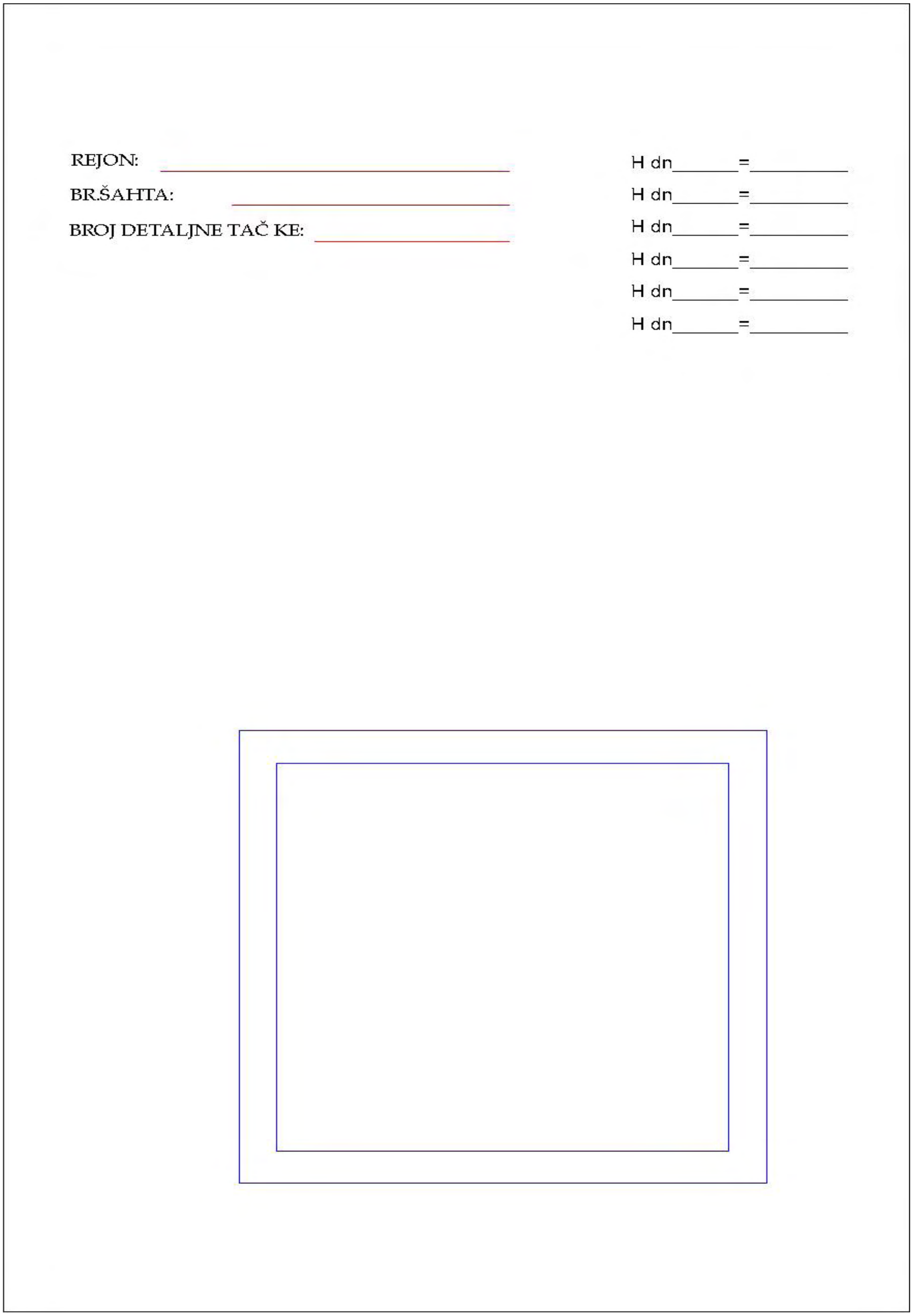


Diagram 6 – Diagram for sketching pipe junctions.

ANNEX A-7

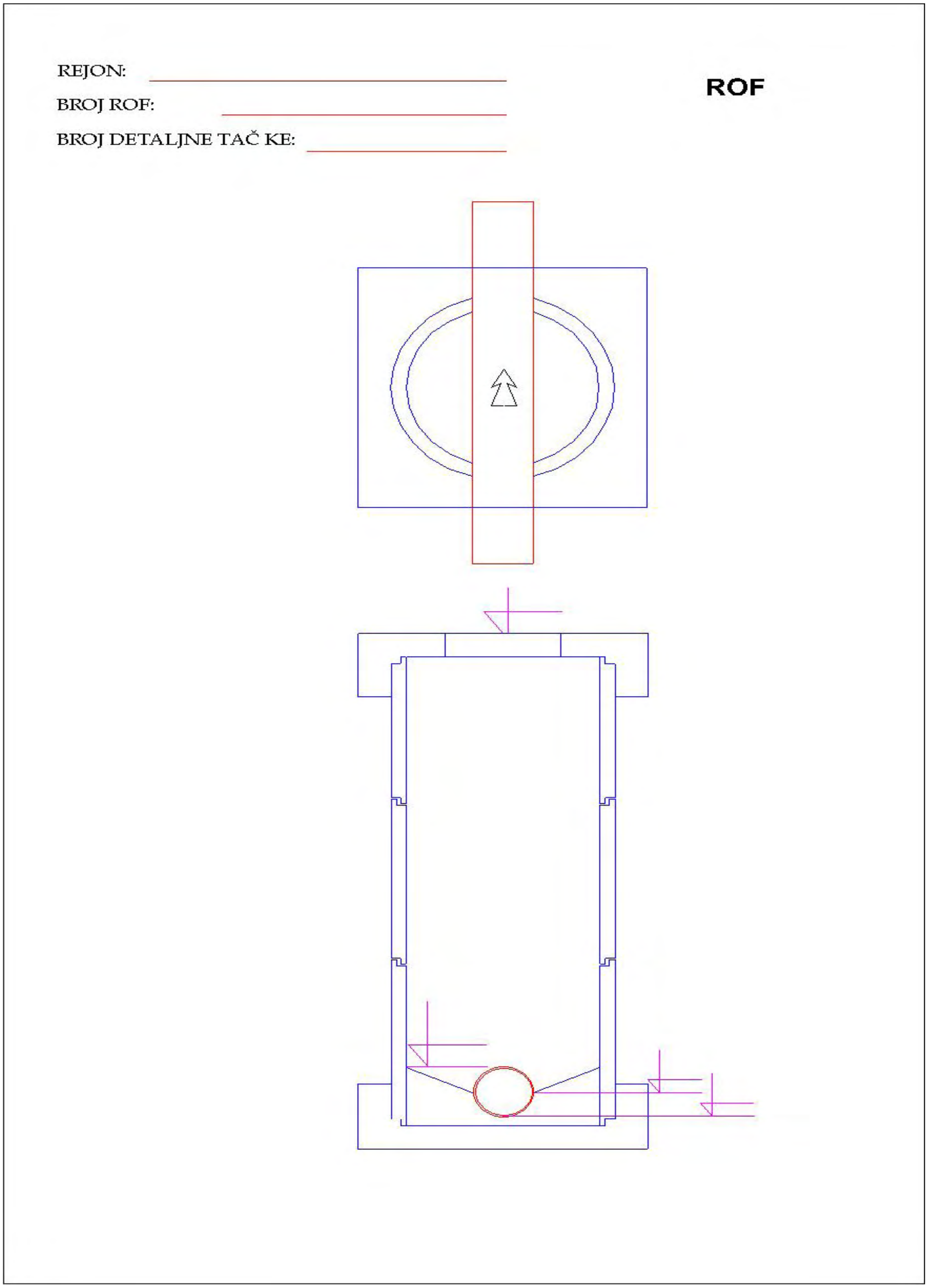


Diagram 7 – Valve Junction Diagram. This diagram can be used to diagram valves in manholes.

ANNEX A-8

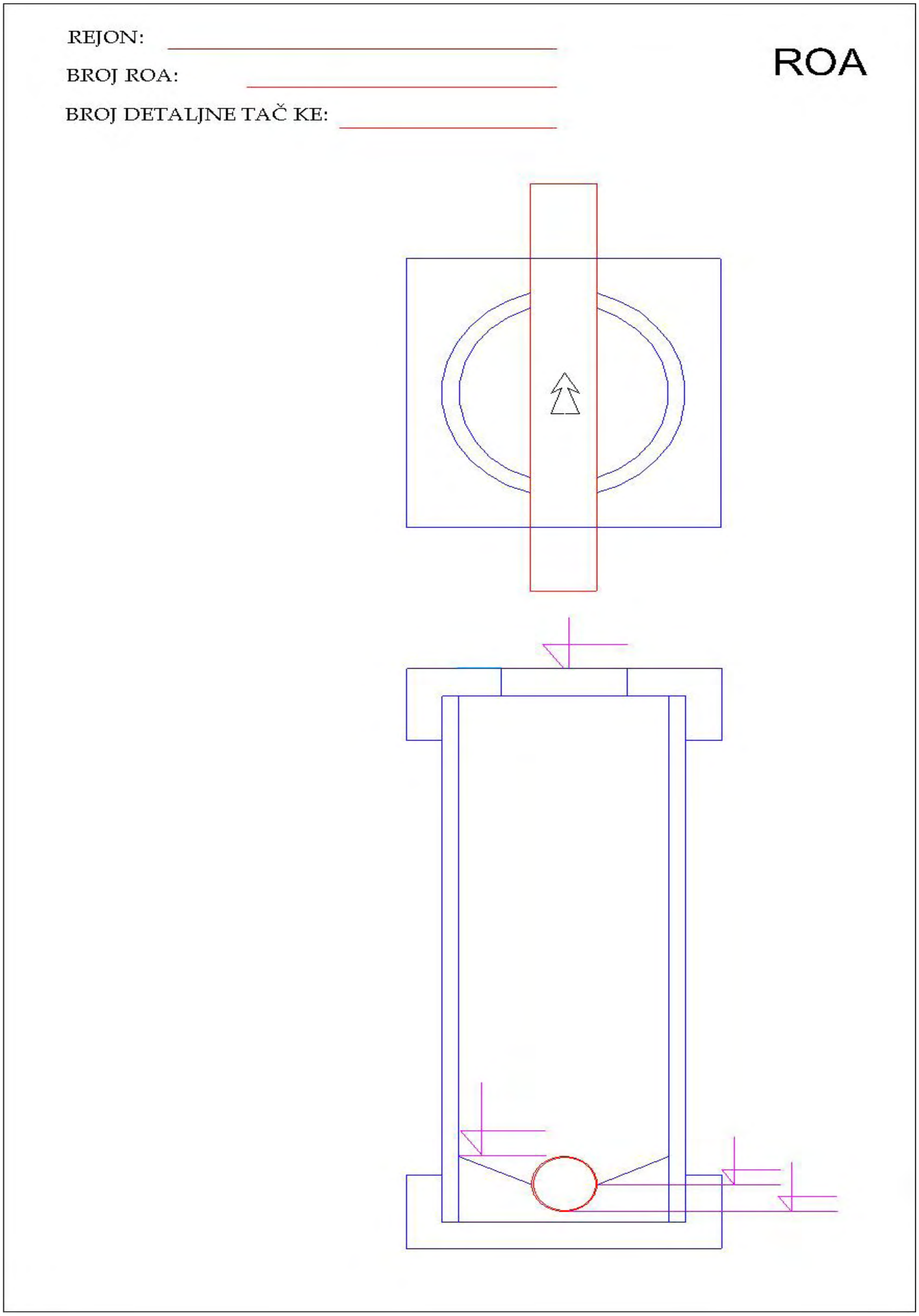


Diagram 8 – Valve junction diagram 2

ANNEX A-9

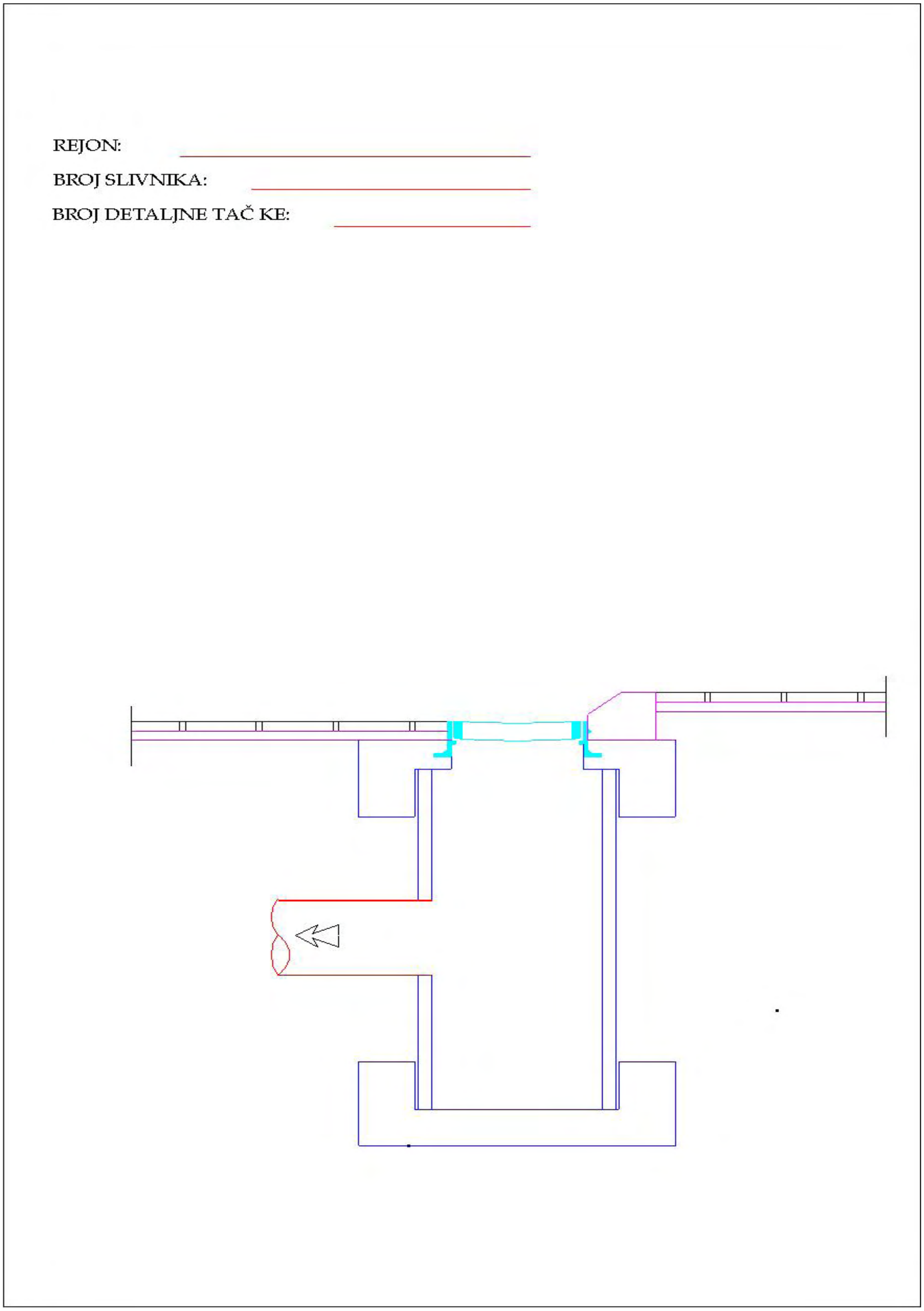


Diagram 9 – Valve junction Diagram 3. This diagram can be used to diagram directional flow through valves.

7.3 ANNEX 2 --INTERNATIONAL GIS STANDARDS REVIEW

The following text was adapted from the "*MINING SURVEYS PART 1*" manual (pages 31-43), which was developed by Dr. Momcilo Pataric, and will provide information on the requirements for accurate measurements in spatial-location systems for former Yugoslavia (i.e. GIS).

COORDINATE SYSTEMS IN FORMER YUGOSLAVIA

Because former Yugoslavia covers between 14˚ Latitude and 23˚ Latitude from the Greenwich meridian, the main meridians are on 15˚, 18˚, and 21˚. These projections are represented on the X-axis of all coordinate systems. The projection of the Equator has been established as the ordinate, Y-axis of all coordinate systems.

Each of these copied zones has its own number, derived by dividing geographic length of the main meridians 15˚, 18˚, and 21˚ by three. So in Yugoslavia, we have three coordinate systems with numbers 5, 6 and 7 (see diagram below).

Positive direction of the X-axis is from the beginning of the coordinate system toward North, and positive direction of the Y-axis is from the beginning of the coordinate system toward East.

In order to avoid negative values of ordinates, ordinate value of the beginning is not zero as usually, but 500,000 m. That way, places east from X-axis will have ordinates bigger than 500,000, while places west from X-axis will have ordinates smaller than 500,000.

The number of the system is put before the ordinate value in order to make clear which coordinate system a specific place belongs to. This way of marking right-angled Gaus-Krϋger coordinate systems was proposed by a German geodetic engineer Baumgarten.

In the example of a place with ordinate:

Y = 7.460762,771

Belongs to system 7, and it is located west from X-axis on:

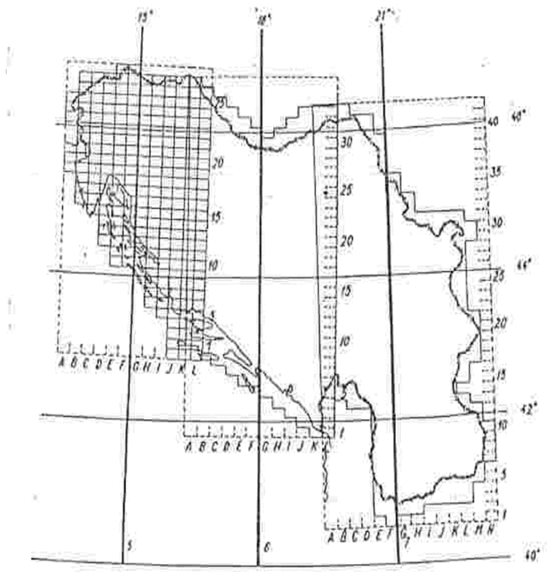
7,500,000.000 – 7,460,762.771 = 39,237.229 m.

With geographic width in Yugoslavia, the biggest distance of a place left or right to the X-axis is about 127 km.

If the abscise of a place is:

X = 4,948938.549

This means that is its distance from the Equator.

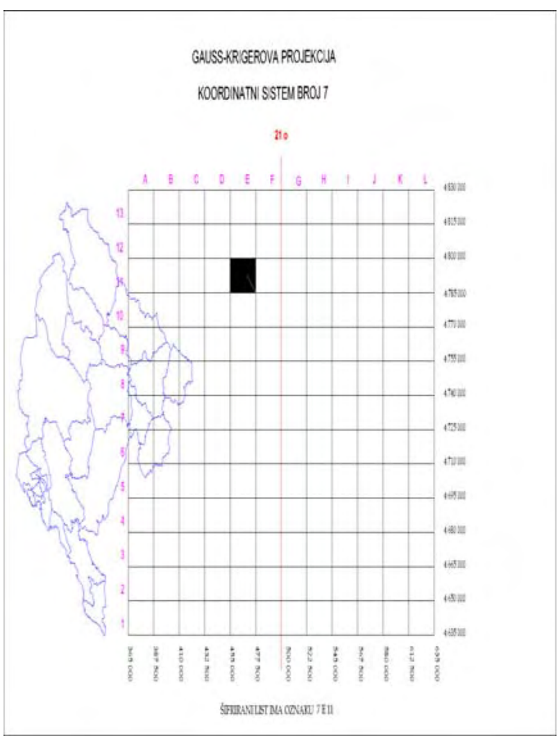


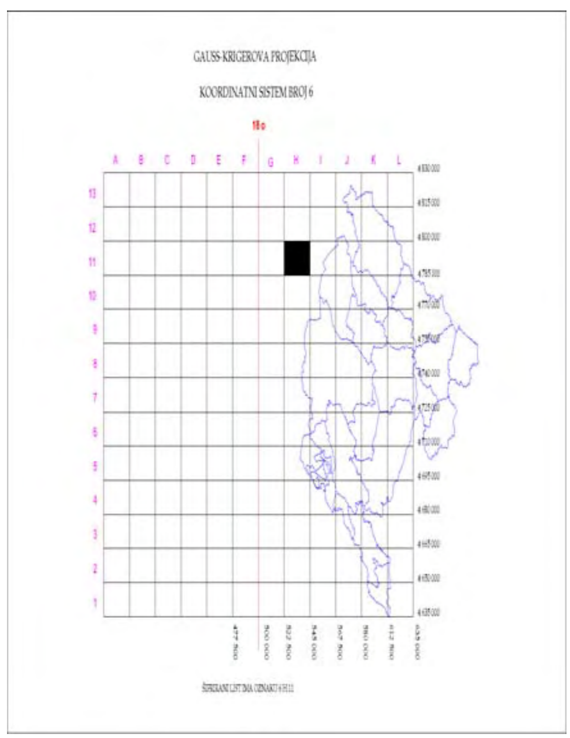
For beginners, some confusion could result from the orientation of the geodetic coordinates system, where X-axis is vertical and Y-axis is horizontal.

This is because with right-angled coordinate systems, angles are marked with the abscise as the main direction, while the main direction on the Earth is South-North. From the main directions, angles are oriented toward East, so + (positive) X axis is actually the north direction. This layout does not cause contradictions in the matter of the symbol of absolute values of coordinates and trigonometric functions in relation to the basic coordinate system.

GAUSS -KRUGER PROJECTIONS IN YUGOSLAVIA

Example of map type 4 (1:25,000) of the trigonometric network divided into quadrants





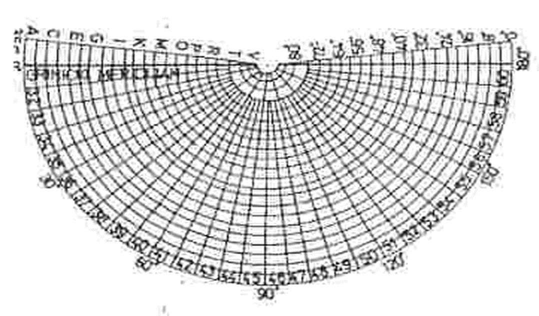
MAPS, PLANS, NOMENCLATURE

It is understood from previous chapters that the results of measurements are shown with numbers by means of coordinates and altitudes in a precisely defined coordinate system, or with graphs, like topographic maps and topographic plans.

Engineers belong to a group of technical specialists who have maps and plans as basic graphic documentation. This is evidenced in all areas of their work: from research, project-development, project execution, all the way through project follow-up. Therefore, it is important to outline in general terms the types of maps and plans that engineers encounter in their practice. The term *map* or *plan* depends on the ratio. Commonly, for “small” ratios like 1:5,000 and smaller: 1:10,000, 1:25,000, 1:50,000, 1: 100,000, 1:200,000, 1:1,000,000 the term map is used; while ratios 1:2,500, 1:2,000, 1:1,000, 1:500 are named plans. For 1:5,000 ratios, although the alternative term exists, the most common one is basic state map. Depending on the purpose, the general classification is to military-topographic maps and topographic plans.

MILITARY-TOPOGRAPHIC MAPS

Military-topographic maps have their generator and user (purpose) defined by their name. For these kinds of maps, we have a ratio system: 1:25,000, 1:50,000, 1: 100,000 and 1:200,000. A basic map is 1:25,000 ratio map and it serves as a cartographic source for production of maps with smaller ratios. It is produced by using the research data and not using an existing map; and as such, represents a capital work of cartography and geodesy. That kind of map for the whole territory of Yugoslavia is produced by the Military Geographic Institute. The classification and nomenclature of these maps starts from the international 1:1,000,000 map, of which the production was agreed upon in 1909 in London and in 1913 in Paris. The way this map is divided is shown in Picture 2.18. Every quadrant has 4º of geographic width and 6º of geographic length. In accordance with the established nomenclature, its mark contains a letter of Latin alphabet and a number 1-60. The letter marks the position of the map in the area from the Equator to the pole; the number marks the position in relation to geographic length, which is counted starting from 180º of geographic length by Greenwich.



According to this classification and marking system, the territory of Yugoslavia is covered with four quadrants of the 1:1,000,000 map, marked with K and L of geographic width and 33 and 34 meridian zones.

According to the established marking system, those quadrants are: L 33-Zagreb, L 34-Belgrade, K 33-Roma and K 34-Skopje.

The following Column contains the data which shows the system of further dividing of topographical maps into bigger ratios, within the international 1:1,000,000 map.
The two pictures on this page show the list of the topographic maps used in the country with ratios. They are the following:

- The general topographic 1:200,000 map, made of four special 1:100,000 maps. Every quadrant is named after the largest town in the area represented by the map.

- Special topographic 1:100,000 maps are made of four 1:50,000 quadrants. Each quadrant is named after the largest town in the region represented by the map, and the 1:50,000 quadrants are marked by numbers 1, 2, 3 and 4.

TABLICA 2

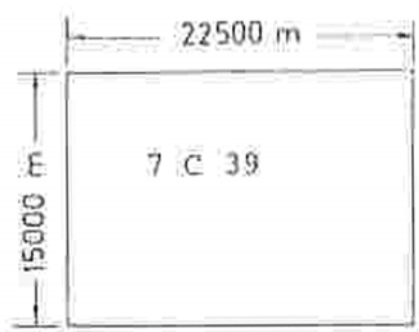
Razmera	Lučne dimenzije φ	Lučne dimenzije λ	Broj listova u predhodnoj razmeri
1 : 1.000.000	4	6	1
1 : 500.000	2	3	4
1 : 200.000	1	1	6
1 : 100.000	30'	30'	4
1 : 50.000	15'	15'	4
1 : 25.000	7,5'	7,5'	~~8~~4

1.2.2 TOPOGRAPHIC PLANS

Topographic plans, with ratios 1:5,000, 1:2 500, 1:2 000, 1:1 000 and 1:500, are more important for engineering than topographic maps with smaller ratios. They are a cartographic basis for production of detailed and implementation projects of specific constructions. By means of graphical reading, it is possible to obtain the necessary data for a projected construction, and to use it for marking the exact location. The aforementioned topographic maps also have their purpose in wider regional research and studies containing draft plans.

DIVIDING PLANS INTO QUADRANTS

An engineer's expertise is mostly related to project planning and implementation; i.e., the usage of topographic plans with horizontal or vertical representation of the terrain. In order to explain nomenclature and ratios of plans, a review of the coordinate systems 5, 6 and 7 from the previous chapter is necessary. These coordinate systems are divided into trigonometric sections, with functional space on the quadrant for 1:25,000 ratio, 60cm on the X-axis and 90cm on the Y-axis. In reality, that is 15,000 m on the X-axis and 22,500 m on the Y-axis. Marking is done in the X-axis with Arabic digits, and with Latin letters on the Y-axis.



This way, it is possible for every quadrant with a specific ratio to have a marking for its place in the coordinate system. Fitting of specific ratios is done in steps. It starts with dividing the trigonometric section into quadrants with 1:10,000, 1:5,000, 1:2,500 and 1:2,000; then dividing the 1:5,000 quadrants into 1:1,000 and 1:500 quadrants. The bases for this are trigonometric sections. The dimensions of functional space on the quadrants on X and Y axis are shown in Column 3.

TABLICA 3

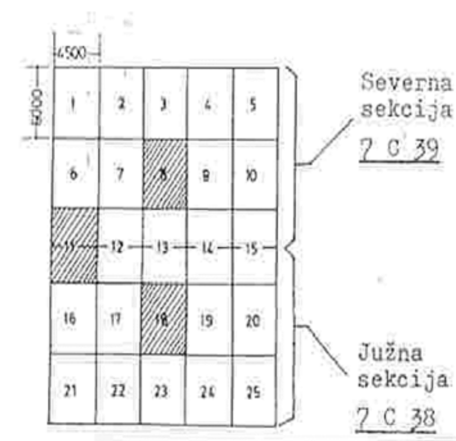
RAZMERA	VELIČINA KORISNOG PROSTORA			
	NA LISTU [cm]		U PRIRODI [m.]	
	x	y	x	y
1 : 10 000	60	45	6 000	4 500
1 : 5 000	60	45	3 000	2 250
1 : 2 500	60	90	1 500	2 250
1 : 2 000	50	75	1 000	1 500
1 : 1 000	50	75	500	750
1 : 500	50	75	250	375

Pictures 2.22-2.28 show the means of dividing and nomenclature from trigonometric section to a 1:500 ratio quadrant. It can be seen from these sections that every quadrant of the plan, no matter its ratio, has its place in the coordinate system, marked by a code, according to the established nomenclature.

When creating projects for specific constructions, it is necessary to use multiple quadrants with certain ratios and make one map - a cartographic basis for the territory. In such cases, it is necessary for an engineer to know the nomenclature and ratios in order to ask the measuring service, or another cartographic institution, for the necessary quadrants.

DIVIDING A TRIGONOMETRIC SECTION INTO QUADRANTS OF THE BASIC STATE MAP WITH 1:10,000 RATIO

Functional space on the quadrant with 1:10,000 ratio is 60 x 45 cm, or in reality x = 6,000 m, y = 4,500 m. When fitting the 1:10,000 quadrants to 1:25,000 ratio, one does not get the number of whole quadrants on X-axis (15,000:6,000 = 2.5). This is why we take two quadrants of the trigonometric section from the same column, from two neighboring rows (2 x 15,000:6,000 = 5). The result is 5 rows by the X-axis and 5 columns by the Y-axis.

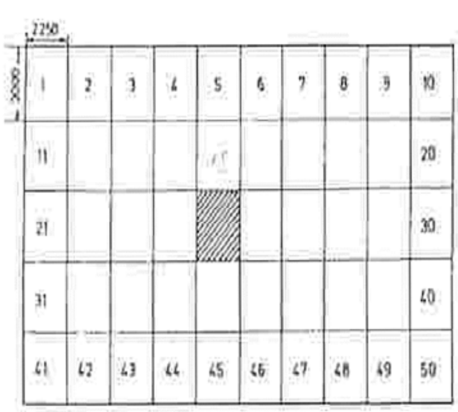


Trigonometric sections are taken in the following way:

- in zones 5 and 6 for southern-lower section, we take the one with an odd number
- in zone 7 from southern section, we take the one with an even number

DIVIDING A TRIGONOMETRIC SECTION INTO QUADRANTS OF THE BASIC STATE MAP AND PLAN WITH A 1:5,000 RATIO

Functional space for this ratio is 60 x 45 cm, or in reality x = 3,000 m, y = 2,250. After dividing the dimensions of the trigonometric section with these numbers, the result is 15,000:3,000 = 5 rows and 22,500: 2,250 = 10 columns. One section contains 50 1:5,000 quadrants, marked with numbers 1-50, left to right.

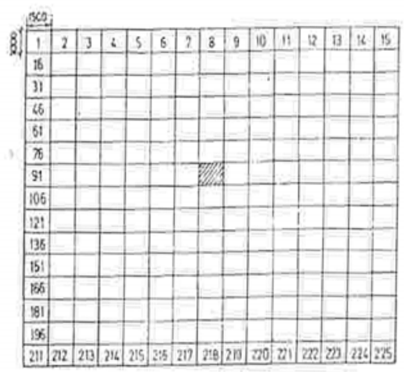


DIVIDING A TRIGONOMETRIC SECTION INTO 1:2,500 QUADRANTS

Functional space for this ratio is 60 x 90 cm, or n reality x = 1,500 m, y = 2,250 m. After dividing the dimensions of the trigonometric section with these numbers, the result is 15,000:1,500 = 10 rows and 22,000:2,250 = 10 columns. One section contains 100 1:2,500 quadrants, marked with numbers 1-100, left to right.

DIVIDING A TRIGONOMETRIC SECTION INTO 1:2,000 QUADRANTS

Functional space for this ratio is 50 x 75 cm, or n reality x = 1,000 m, y = 1,500 m. After dividing the dimensions of the trigonometric section with these numbers, the result is 15,000:1,000 = 15 rows and 22,500:1,500 = 15 columns. One section contains 225 1:2,000 quadrants, marked with numbers 1-225, left to right.

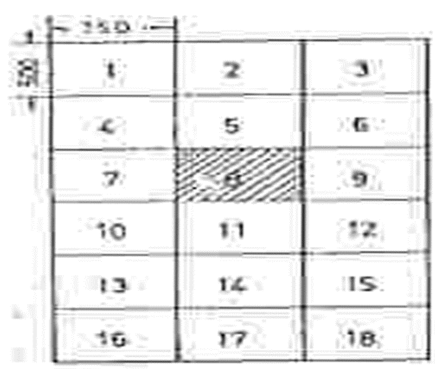


DIVIDING THE BASIC STATE 1:2,000 MAP INTO 1:1,000 QUADRANTS OF A PLAN

For dividing and nomenclature of 1:1,000 and 1:500, the basis is a 1:5,000 ratio quadrant. Functional space for 1:1,000 quadrants is 50 x 75 cm, or in reality x = 500 m, y = 750 m. After dividing the dimensions of a 1:5,000 quadrant with these numbers, the result is 6,000:500 = 6 rows and 2,550: 750 = 3 columns. One 1:5,000 quadrant contains 18 1:1,000 quadrants, marked with numbers 1-18, left to right.

DIVIDING THE BASIC STATE 1:5,000 MAP INTO 1:500 QUADRANTS OF A PLAN.

Functional space for 1:500 quadrants is 50 x 75 cm, or in reality x = 250 m, y = 375 m. One 1:1,000 quadrant contains 4 1:500 quadrants, and a 1:5,000 ratio quadrant contains 4 x 18 = 72 1:500 quadrants.



The marking of a 1:500 ratio quadrant has the marking number of a 1:1,000 ratio quadrant plus the marking letter of a 1:500 ratio quadrant.

7.4 ANNEX 3 --DATABASE TRAINING MANUAL

Throughout the text, the term "database" has been used multiple times. The following Annex will provide a brief definition and training on the use of a database, as well as basic terminologies.

The term "database" refers to a method of storing related data, organized especially for rapid search and retrieval. A database is one or more large-structured sets of persistent data, usually associated with software to update and query the data. A simple database might be a single file containing many records; each of which contains the same set of fields and where each field is a certain fixed type.

Imagine a database as a grid of information. In this grid there are vertical and horizontal lines. The horizontal lines in the grid are called *rows.* The vertical lines in the grid are called *columns.* The intersection points of the rows and columns are called *fields.* The following is a description of all three:

Field: A field is the smallest unit within a database. It is the cross-reference point where a row and a column meet. Each field is an element of a database record in which one piece of information is stored. A field can only hold a singular piece of information about a singular entity within the database. The stored information in a field refers to the information called for by the intersection point of the row and column to which it corresponds. For example: if a database of customers has a column for address, and the customer record in row 21 is "Customer A", then the field at the intersection of row 21 and the address column should contain the address information of "Customer A".

Because they are the smallest and most precise units of a database, fields are used to search the structure of a database for information. When a database is searched for information, the computer analyzes each field in a column and compares it to a pre-determined set of search criteria, then lists all objects found matching the given description. The diagram below highlights an individual field and how it is used within the overall structure of a database.

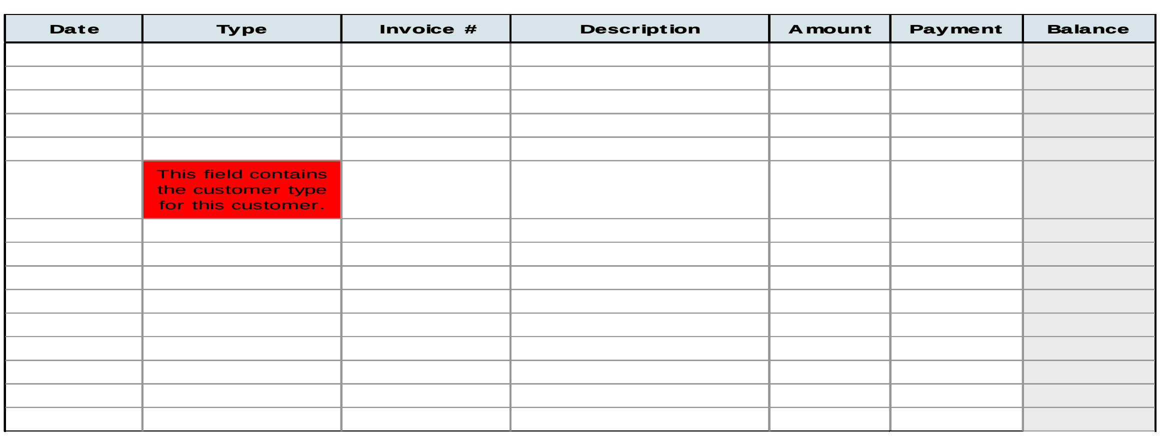


Diagram 1 -- A Field within a database

Row: A row in a database is a horizontal arrangement of data specific to a singular entity. The data stored in a row is determined by its corresponding column. A row has a single identifier, which is its “subject”. All other data contained within the fields making up a row are related in some way to the primary identifier. The Primary Identifier of a row is whatever the main search criteria for a database are set as. If the primary search criteria for a database are a customer code, the customer code is the primary identifier.

Rows can contain almost endless amounts of information on a singular entity. However, a row must always consist of a singular entity, and can never describe more than one entity. For example; the information describing John Doe from 123 Anywhere Street, must be kept in a separate row from the information describing John Doe from 321 Anywhere Street.

Date	Type	Invoice #	Description	Amount	Payment	Balance
This is a row,	a row contains infor	mation on an enti	ty within a database. This	row contain	s customer i	nformation

Diagram 2 – Example of a Row

Column: A column is a vertical arrangement of information on a singular topic. The information contained within a column is dictated by its corresponding row. When a database is searched, it is searched by information contained within a column. The information in any given column can only consist of one type of information per column. For every necessary piece of information pertaining to a row within a database, a new column must be created. For example; if a database must classify customers by the following criteria: Name, Address and Telephone number; then individual columns must be made for all three criteria.

Date	Type	Invoice #	Description	Amount	Payment	Balance
	This is a column,					
	it holds informtation					
	on each customer.					
	This column					
	specifies the					
	customer type					
	for the database					

Diagram 3 – Example of a Column

7.4.2 Database Terminology

There are several terms used when referring to databases. Understanding the terms and the entities to which they refer is the key to understanding the technology and its uses. The following is a list of basic database terminology.

Data Entry: *Data entry* refers to the process of entering data into a database. There are two basic methods of data entry: manual and automated. Manual data entry involves the hand entry of each record into a database by an operator. Automated data entry uses "macros" to transfer information from a source into a database.

Macros: *Macros* are specialized mathematical formulas written to automate the process of data entry. A "macro" takes information from a given source and, through a mathematical conversion, turns it into information that is then entered into the appropriate location within a database.

Column: A *column* is a single store of related information. A column consists of records, and each record is made up of a number of fields. The phone book is an example of a column, in that it contains a record for each telephone subscriber; and the details for each subscriber are contained in three fields – name, address, and telephone number.

Primary Identifier Key: A *primary identifier key* is a field that *uniquely* identifies a record in a column. In a database of students at a university, for example, a key built from the columns "last name" and "first name" might not give you a unique identifier if there were two or more students with the same name in the school. To uniquely identify each student, you might add a special Student ID field to be used as the primary identifier key.

Index: An *index* is a summary column which allows a particular record or group of records in a column to be located quickly. Similar in use to the index of a book, the summary column, or index, is a quick jumping off point to finding full information about a subject. A database index works in a similar way. An index may be created on any field in a column. For example, a customer column contains customer numbers, names, addresses and other details. An index can be created based on any information contained in that column, such as the customers' "customer number", "last name", "first name" (known as a composite index, which is an index based on more than one field), or "postal code". Then, when searching for a particular customer or group of customers, the index can be used to speed up the search.

7.4.3 Types of Databases

There are two main types of databases: relational databases and flat-file databases. The type of database necessary for a specific application depends on the type of data that is to be stored within the database(s). The following section will briefly describe the differences between the two primary types of databases.

Flat-File Databases: A flat-file database is a database that consists of a single column, with no informational links at all. An example of a flat-file database would be a listing of customer records for a business. The database would contain information on all customers of the business, but there would be no further links to information.

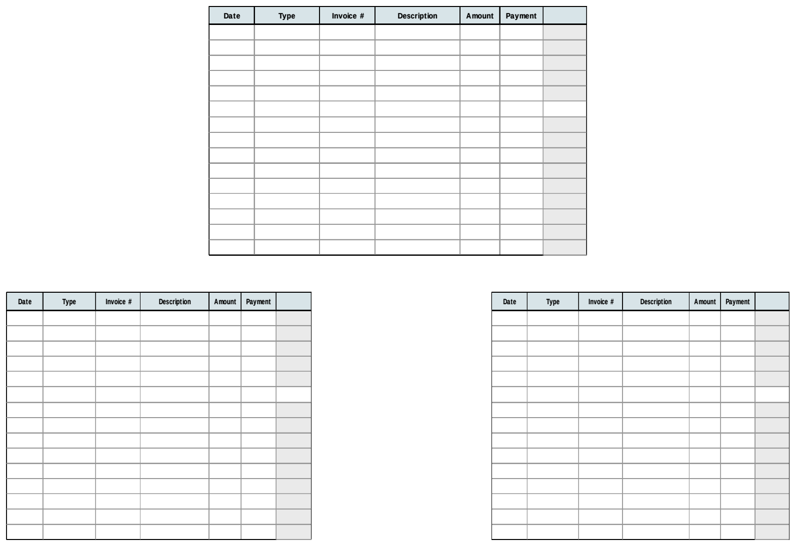


Diagram 4 – A flat-file database structure.

Relational Databases: A relational database is a group of columns linked together to form a “web” of information. Within relational databases, there are links act as a bridge between separate columns in other databases, effectively creating a network of databases. An example of a relational database would be a customer database for a large store containing a column for items purchased in the last six months. In a relational database, this column could contain a link to a database of all items in the store’s inventory, or a database of all of the stores that carry such items.

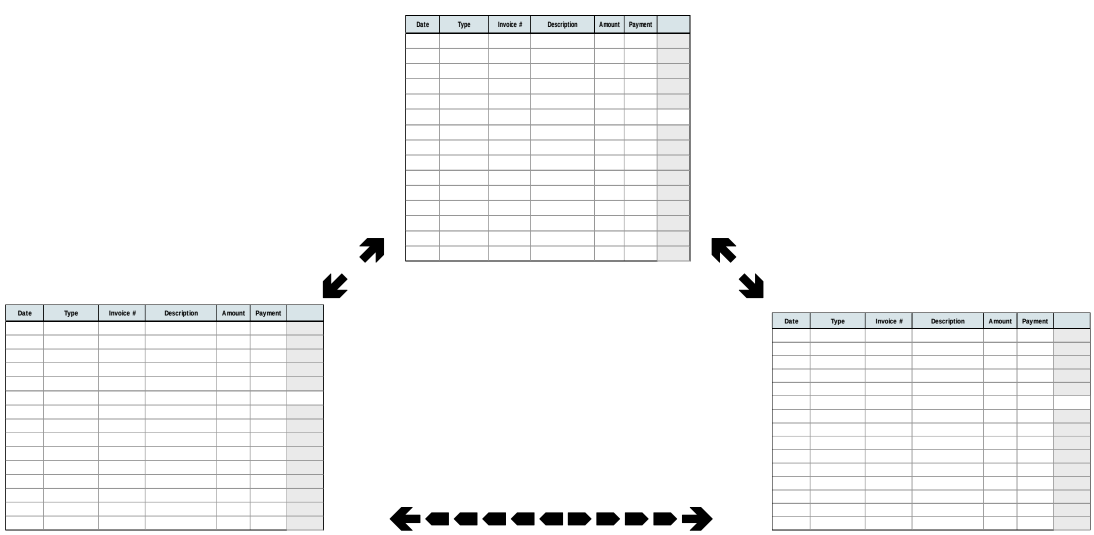
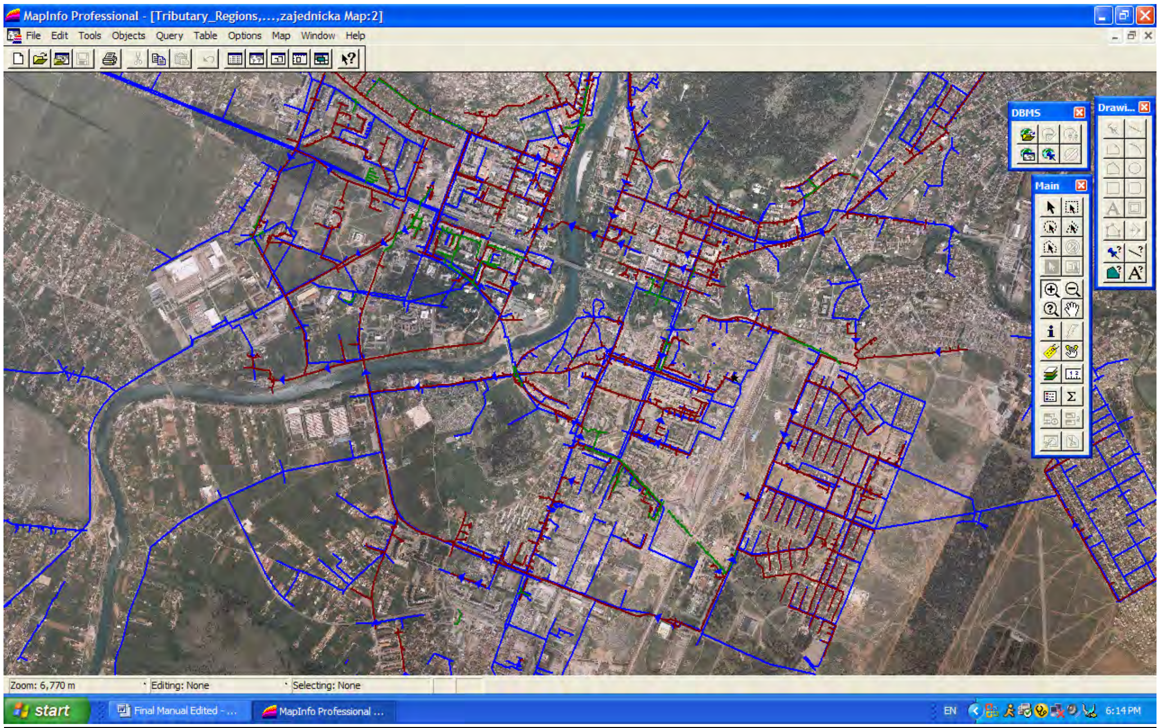


Diagram 5 – Structure of a relational database

7.5 ANNEX 4 -- MAPINFO TRAINING MANUAL

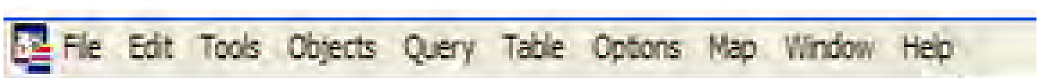
The term "Viewing Software" has been used multiple times throughout this text. The recommended software for usage with this manual is *MapInfo Geo-Spatial Viewer Version 7.5.* The following annex is a brief training manual for the uses of MapInfo software. This training manual will provide a reference point for all users to consult during and after the implementation process.



1. INSTRUCTIONS FOR OPENING FILES

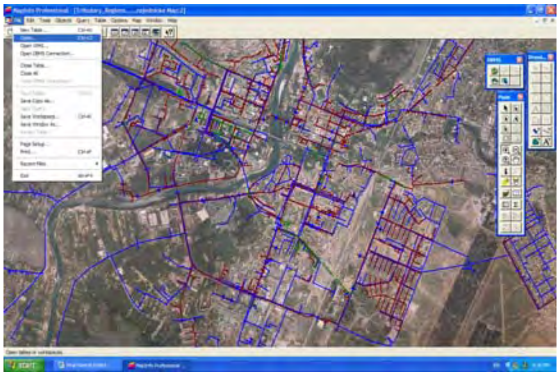
Drawings and databases of elements for the GIS are stored in a system of **COLUMNS**. **COLUMNS** are vertical rows in a database that hold one specific type of information for the GIS. All listed elements of the GIS, are organized in groups of files and Columns in a database that are stored as a **WORKSPACE**, or an organized group of **COLUMNS**.

The opening and closing of a file, or files, is done by selecting a command with the cursor.



↳ From the dropdown box of the drop down **FILE** menu, choose the command **OPEN FILE,** and the **OPEN FILE** dialogue window appears.

↳ In the **OPEN FILE** dialogue window, choose the directory containing the desired file (in the case of the tutorial, the subdirectory will be located in a file called "GIS").



↳ Select the desired file by double clicking on the appropriate file name (or one right click and then one left click on the command **OPEN**). This way it is possible to open another file or a database over the objects in a file. It is also possible to open several files from the same directory, by selecting the first picture and holding the **CONTROL** button on the keyboard and widening the selection by holding the left mouse button and moving the cursor around the desired selection.

↳ To open the database of the objects in the file, choose the **OPEN FILE** option in the **PREFERRED VIEW** selection, under the **VIEW** drop down menu.

↳ Choose the **BROWSER** command, and the file selection window is opened automatically.

↳ Selecting the square symbol in the upper right hand corner of the newly opened window maximizes the file to fit the whole screen.

↳ After the file has been opened, it is possible to perform a series of operations and changes to the file using the commands from the **MAIN** and **DRAWING** drop down menus.

↳ After examining the file and making the necessary changes, the file can be closed by choosing the command **CLOSE** on the **FILE** drop down menu, which opens the **CLOSE COLUMN** dialogue box.

✳ **NOTE: CLOSING A FILE DOES *NOT* AUTOMATICALLY SAVE THE WORK DONE IN THE PREVIOUS SESSION**

↳ In the **CLOSE COLUMN** dialogue box that appears, choose the file that you want to close. If you are working on multiple files (if only one file was opened, the selection is automatic), choosing the command **CLOSE** closes the file. If any changes were made, a new dialogue box will appear with the following options:

SAVE = Saves individual changes made to the file

SAVE ALL = Save all changes without the ability to discard individual changes

DISCARD = Does not save individual changes made to the file

DISCARD ALL = Closes file without saving any changes made

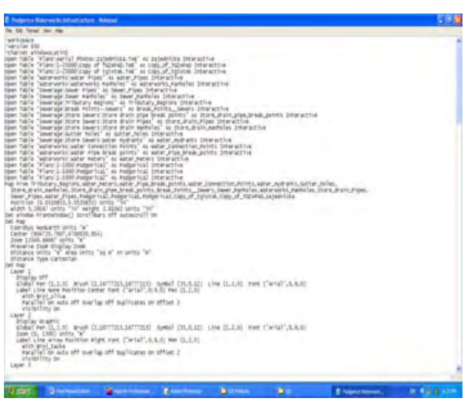
CANCEL = Quit from closing the file, and return to the workspace

CLOSE ALL = Close all files *without* saving.

↳ To quit the program, choose the command **Exit** from the **File** submenu.

OPENING AND CLOSING AN ORGANIZED GROUP OF FILES (WORKSPACES)

Files within a specific group of files, known as a **WORKSPACE,** can be opened at the same time to view them in combination. It is not always possible to view all files at the same time, as the data represented would become confusing and run together. However, if it is precisely defined what ratio of zoom makes a layer visible, and what ratio of zoom makes an image disappear from the screen, the data can be highly organized. All the files held within a **WORKSPACE** do not necessarily have to be stored in the same directory.



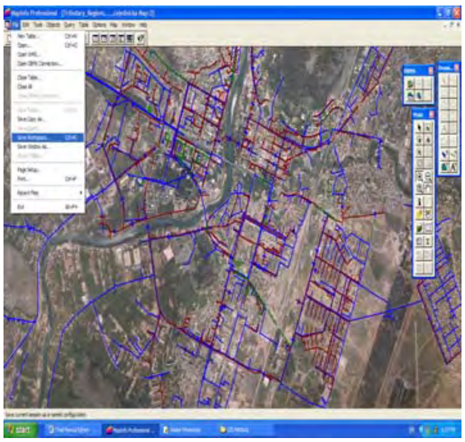
A **WORKSPACE** is only a textual description to the computer of what files, databases and settings the combination of files contains, and in which way they are organized. This way, instead of opening one file at a time, to analyze or change a group of files, and resetting the parameters in every file all over again every time, we can simply save that combination under a separate file name, known as a **WORKSPACE**, and re-open it automatically as necessary.

Forming of an organized group of files is done by opening all of them at the same time, or one at a time, and setting the suitable parameters (visibility, kinds of lines symbols and fonts), then saving the combination as a **WORKSPACE,** with a name under which it will be opened in future.

✳ **WORKSPACE** files have the extension **.WOR** after the file name

SAVING A GROUP OF FILES AS A WORKSPACE:

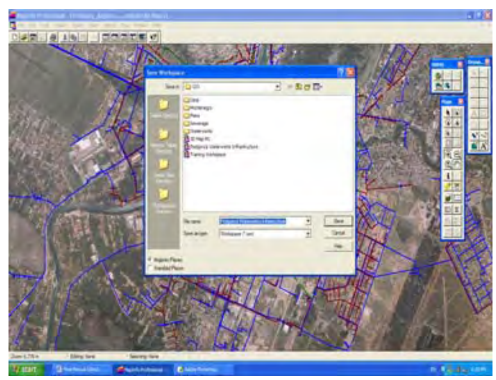
To save a group of files, first open all files that you want included in the overall **WORKSPACE** file. After all files have been opened, then set all parameters to the desired settings and use the following procedure to save all the files and settings as **WORKSPACE:**



↳ On the **FILE** drop down menu, select the command **SAVE WORKSPACE** and the **SAVE WORKSPACE** dialogue box will open.

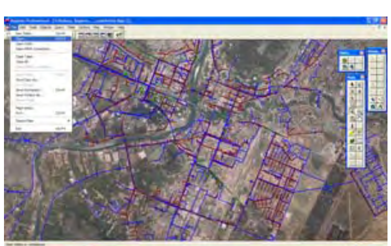
↳ In the dialogue box, define a name of the group of files and its directory and save it by choosing the **SAVE** command. When opening that group of files (**WORKSPACE**) again, the first file on the screen will be the same one that was on the screen when the group of files was saved.

✳ NOTE: When changing the filenames in a Workspace, it is necessary to resave the workspace with the *NEW* filenames; otherwise the workspace files cannot be re-opened.



OPENING A PREVIOUSLY SAVED WORKSPACE

↳ On the **FILE** drop down menu choose the command **OPEN WORKSPACE**, and the **OPEN WORKSPACE** dialogue box shows on the screen.



↳ On the dialogue box choose the directory containing the group of files you want to open and select the group (Selections can be opened by double clicking on the left cursor button on the name of the workspace, or by single-clicking on the right button when the name of the Workspace is highlighted, and one left-click on the command **Open** command)

- ↳ After opening a group of files (**WORKSPACE**), it is possible to perform a number of operations and changes on the separate files using commands from the **MAIN** and **DRAWING** menus.

- ↳ After examining a group of files (**WORKSPACE**) or making the necessary changes on a file or its spreadsheet, you can close the group of files (**WORKSPACE**) by choosing the command **CLOSE ALL** on the **FILE** drop down menu, and selecting the appropriate saving option from the **SAVE FILES** dialogue box.

If any changes were made to the **WORKSPACE**, a dialogue box will show up warning that changes have been made to some files, or their databases, and asking for every file separately whether you want to save the changes with the following options:

SAVE = Saves the changes

SAVE ALL = Save all the changes on all files

DISCARD = Does not save individual layer changes

DISCARD ALL = Discards all Changes without saving

CANCEL = Cancels the closing of the group.

After you choose the suitable option, the group of files (**Workspace**) closes. You can also open several organized groups of drawings and spreadsheets (**Workspace**) at the same time, and have them all on the divided screen.

VIEWING MULTIPLE WORKSPACES AT THE SAME TIME:

- ↳ In order to see both groups of files, choose the command **Tile Windows** (divides the screen) from the **Windows** drop down menu.

- ↳ If you want to have only one **Workspace** across the whole screen, you can spread it by selecting the square symbol in the upper right hand corner of its frame.

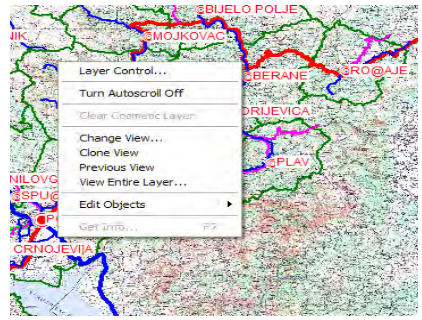
- ↳ You can go back to the divided screen by selecting the symbol of two overlapping squares in the upper right hand corner of the frame.

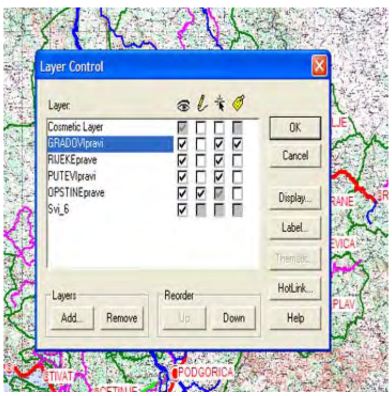
2. OVERVIEW AND ANALYSIS OF FILES AND COLUMNS

When one file or a group of files (**WORKSPACE**) is open, it is possible to perform a number of operations. These operations include: modification of objects on a map, updating of previously created information, and overviews and analysis of files. The modification of objects can be made to files by using the tools from the cascade menu **MAIN** in the following way:

ENABLING LAYER EDITING

↳ In order to make the selection of an object in a file, that file has so be in a state of *enabled selection*, which can be activated by opening the **LAYER CONTROL** drop down menu (control of files and layers) by clicking the right button on the cursor and selecting the **LAYER CONTROL**, or selecting the symbol of multiple layers from the toolbar at the top of the screen.

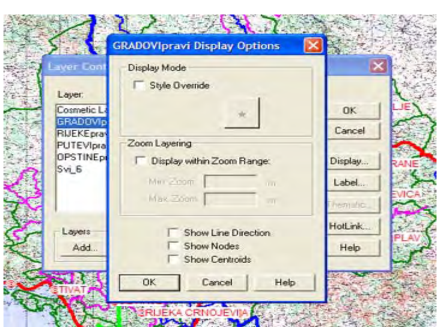




↳ After that, you must select the file on which selection is to be enabled by clicking the name of the file and then clicking on the highlighted square with an arrow in it and confirming the action by clicking **OK**. To disable the selection of objects on individual files-layers repeat the process.

↳ The **LAYER CONTROL** dialogue box is used to set up visibility of a layer (by clicking the square with an eye symbol and confirming on **OK).**

↳ Activate the editing state by clicking the square with a pen symbol and confirming on **OK.**



↳ Activate automatic writing of data from the object in a file from its database by clicking the square with a notepad symbol and confirming the action by clicking **OK** in the **LAYER CONTROL** drop down menu.

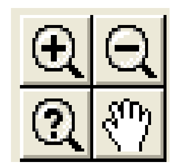
↳ Choosing the drop down menu **DISPLAY** and then choosing **STYLE OVERRIDE**, enables the setting of parameters for the objects on the selected file (i.e., kind and color of lines and surfaces, types and sizes of symbols, fonts).

- Choosing **DISPLAY WITHIN ZOOM RANGE** allows zoom control, and defining what is the zoom that makes the file visible/invisible.
- Choosing the option **LABEL** from the **LAYER CONTROL** drop down menu allows for choosing data to be written next to a specific object (choosing the note symbol), text font, visibility zoom definitions for text, placement of text, etc.

MANIPULATING IMAGES IN MAPINFO

Use the following process to manipulate and modify images and database information within MapInfo. When you are in the process of modifying files in MapInfo, be sure to save work often to avoid having to repeat steps in the event of a mistake of unexpected file loss. These instructions will refer to buttons in the "toolbox", which are the buttons with symbols located in them, and allow different visual or drawing functions to occur.

- To increase the ratio of the map view, select the toolbox button with a "**+** "symbol; every next click will double the ratio of the file on the screen, zooming closer to the location where you clicked before. If you click and hold the left button of the cursor down, simultaneously dragging the cursor, you will create a box around an area that selection will be zoomed in to cover the whole screen. You may return to the previous screen view from before zooming by choosing the option **PREVIOUS VIEW** from the drop down menu box which appears when you click the right button on the cursor.



- To decrease the ratio, select the toolbox button with a "**-** "symbol and click the left cursor button. Every next click will decrease the ratio by 50% with the center of the file on the place where you clicked. If you hold the left cursor button, and simultaneously drag the cursor in any direction, then release, the content of the selection box will decrease to the content of the frame. In order to go back to the screen before zooming, choose the option **PREVIOUS VIEW** from the dialogue box which appears when you right-click the cursor.
- To define the ratio of the file on the screen, click the toolbox button with the symbol "**?**", which will open the **CHANGE VIEW** dialogue box, where you can adjust the ratio of the image by defining the width of the screen (**ZOOM WINDOW WIDTH = M**) or by defining the value of ratio (**MAP SCALE 1 MM= M**).
- To move the file across the screen, select the toolbox button with the symbol of a hand. After that, as you hold the left cursor button and move the cursor in any direction, the file will move across the screen, following the cursor.

↳ To select object in the file, choose the toolbox button with the arrow symbols; the arrow means selection of only one object with a cursor (you can add more objects by holding the **CONTROL** button on the keyboard and continuing selection with a cursor), the arrow in the square enables selection of all of the objects contained in the square which is formed by moving the mouse while holding its left button; the arrow in the circle enables selection of all objects contained in the circle, which is formed by moving the cursor while holding it's left button.

↳ View database information on an object by selecting the **"I"** button in the toolbox with the cursor and clicking on any image. This shows the information on that object from its database.

↳ To write a piece of data on an object, select the toolbox button with a notepad symbol and click any object with the cursor. This shows the database information on the object from its database, and allows the change of information attributes.

↳ For statistical processing of the data on an object, select the ∑ sign from the toolbox and select a group of objects with the cursor. This will show totals and average values of all numerical data on the selected objects

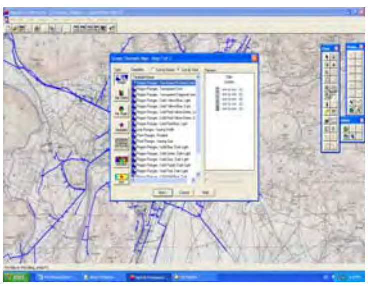
↳ For viewing distance data, select the toolbox button with a symbol of a ruler. This will show a small window with partial (between two points selected with the cursor) and total distances (total of distances between a number of points. Turn this option off by double-clicking the last point selected, or pressing the **ESC** button on the keyboard. The information window for showing distances is closed by clicking the **X** button in the upper right corner of the window.

3. THEMATIC MAPS

One of the very commonly used methods in the analysis of objects in files is the creation of **THEMATIC MAPS** where the differences (based on different attributes from databases) between objects are most clearly seen from all aspects.

The creation of a **THEMATIC MAP** is performed in the following way:

- ↳ From the **MAP** drop down menu, choose **CREATE THEMATIC MAP** option. A dialogue box appears. In this box, **CREATE A THEMATIC MAP STEP 1 OF 3**, choose one of the options for thematic maps:

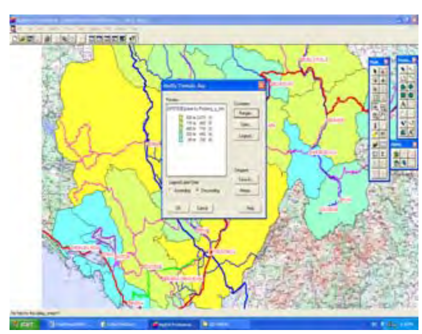


- ☑ **SHADING DEPENDING ON VALUES OF SPECIFIC ATTRIBUTES**
- ☑ **CREATION OF A LEVEL DIAGRAM**
- ☑ **CREATION OF A "PIE" DIAGRAM**
- ☑ **CREATION OF A DIAGRAM BY PHASING**
- ☑ **CREATION OF A DIAGRAM BY THICKNESS OF SPOTS**
- ☑ **COLORING OF INDIVIDUAL OBJECTS**

- ↳ After choosing one of the options for the thematic map, another dialogue box appears, **CREATE A THEMATIC MAP STEP 2 OF 3**. Choose the file (**COLUMN**) from which objects can be examined as well as some data (**FIELD**), or a combination of data which will be the basis for the thematic map.

- ↳ The program will then perform the appropriate calculations and there will be a third dialogue box for **CREATION OF A THEMATIC MAP STEP 3 OF 3,** The recommended legend for the thematic map will appear, with options to change the style, the legend and expanding and contracting view of objects on the map. Thematic maps can be customized to personal tastes by modifying the options in this menu.

- ↳ After these options are defined, press **OK,** and the map will show on the screen. A new layer showing differences between the objects you are analyzing and a legend for the new map will appear.



↳ After creating a thematic map, it is possible to modify it and make additional changes in style, legend settings, expanding and contracting view of objects. This is accomplished with the command **MODIFY THEMATIC MAP** from the **MAP** drop down menu, or with the option **THEMATIC** from the **LAYER CONTROL** drop down menu (or with a right click on the mouse).

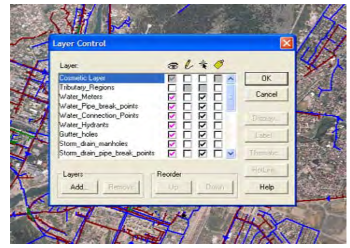
↳ To close a thematic map, open the **LAYER CONTROL** drop down menu (or by right clicking on the mouse) to choose a layer of the thematic map. And select the option **REMOVE.**

↳ Select **OK** when the dialogue box appears asking whether you want to save the thematic map in the combination of files (**WORKSPACE**) should be saved. If this thematic map is not to be saved, choose **DISCARD** and the thematic map will disappear from the screen.

↳ Close the window with the legend (or by clicking the **X** sign in the upper right corner of the map window).

4. Drawing of New Objects

Objects can be drawn on almost any map, as well as be created in databases with MapInfo software. Objects can be created to represent any physical or informational structure. Being able to view data and information depends on the ability to accurately create and modify objects on maps.



- ↳ To make any type of changes, first open the **Layer Control** drop down menu, choose the file to be changed and put it in the state of editing (by clicking on the square with a symbol of a pencil and confirming on OK).

- ↳ If a new file is needed, instead of just a new object in an existing file, all objects have to be drawn on a **Cosmetic Layer**, which has to be put in the state of editing through the **Layer Control** drop down menu.

- ↳ After drawing is finished, objects from the **Cosmetic Layer** are saved in the new file by choosing the **Save Cosmetic Objects** submenu from the **Map** drop down menu.

- ↳ A **Save Cosmetic Objects** dialogue box appears on the screen, asking in which file you want to save the new object in. Choose the option **New** and assign a new name instead of **Untitled** and the objects will be saved in the new file.

It is also possible to transfer new objects from a temporary layer into an existing file (an empty database of that file is automatically assigned for the new objects). In order to do this, complete the following steps:

- ↳ After opening the **Layer Control** dialogue box, choose an existing file, instead of **New**. This will switch the control from a **Cosmetic Layer** to a new layer for the selected file, and at the same time actually create that layer. This is done by drawing at least one new object and selecting **Save Cosmetic Objects.** Drawing of another object is continued in the new layer or in the new file, which, first has to be put in a state of editing in the **Layer Control** drop down menu.

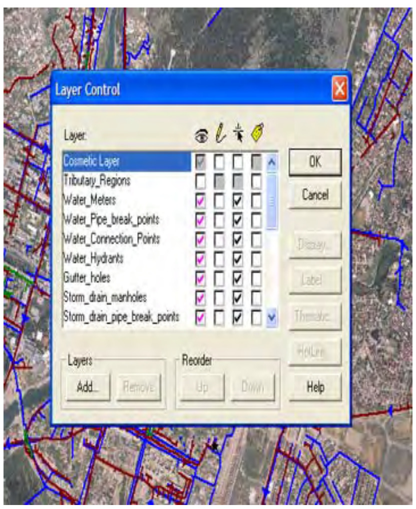
In order to draw new objects use the **Drawing** drop down menu in the following way:

- ↳ First click the button for style adjustment (**?**) and then choose a style for the new object (style of the symbols, lines, surfaces, or text font) in the style adjustment dialogue box.

↳ To draw objects, use the tools for drawing symbols, lines, surfaces (round, square or polygonal) or fonts. The objects on the screen will be drawn in the previously assigned styles. When drawing horizontal and vertical lines between two points, hold the **SHIFT** button while drawing with the cursor. The same procedure can be used for drawing circular selections, with the circular selection tool.

ASSIGNING MULTIPLE STYLES TO ONE COLUMN

Generally, since all objects in a file are of the same type, and are located in the same database (one file for all power plants, one for all pipelines etc.) one style for one file is generally chosen. However, when you want to accent the difference between objects (ex. Power transporters of different voltage) you can assign different styles for certain objects. To do this, use the following steps:



↳ Put the file into the state of editing by opening the **LAYER CONTROL** drop down menu, and clicking the icon of the pen on the appropriate layer, and select the object or objects that will be affected by the style change.

↳ Click the button for style change, and choose the desired style. After you confirm the command, the object will then have the selected style. ***Only the selected objects will be given the new style, all unselected objects will remain unchanged.***

↳ To save the changes on the files during work, choose **SAVE** from the **FILE** drop down menu, or click the icon with a floppy disc under the main menu, then choose the appropriate file and click Save. The **SAVE** command should be executed every few minutes to avoid losing data.

↳ If you do not immediately save a change, there will be a dialogue box asking whether you want to save the changes that have been made when you exit the program. Select **YES** when this box appears to exit the program.

CHANGING THE SHAPE OF BENDING LINES AND SURFACES – POLYGONS

A very useful tool for changing the shape of bending lines (ex: pipelines) and surfaces as well as moving of the bending points is the **POLYGON** symbol, found in the **DRAWING** drop down menu with a symbol of a **POLYGON**. To make relative changes to an object (changing all aspects of the object in relation to a change of one portion), use the following procedure:

- ↳ Turn on the editing state in the **Layer Control** drop down menu.

- ↳ Click on the **Drawing** drop down menu and select the tool shaped as a **Polygon.**

- ↳ Select the object to change with the cursor (four black boxes will appear around the corners of the object when it is properly selected).

- ↳ Make any necessary changes to the object; the **Polygon** tool will make the changes relative to the entire object.

Inserting Additional Break Points

- ↳ Turn on the editing state in the **Layer Control** dialog box

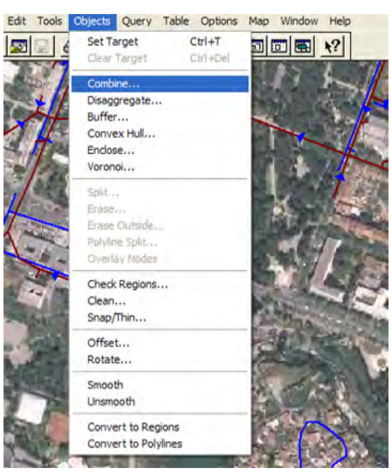
- ↳ For inserting additional breaking points, use the tool showing a point and a + sign in conjunction with the **Polygon** tool on the **Drawing** menu.

- ↳ Click the cursor on a line or side of a surface and form new breaking points, To move, hold down the left mouse button and drag the object to the desired location.

- ↳ When drawing and changing various shapes, a useful tool is **Snap**, which can be activated by pressing the **S** button on the keyboard. With **Snap** turned on, moving the cursor over the object, will show a cross which accurately identifies all the points on the objects.

Joining two or more objects (lines or surfaces) into one

It often happens that a line or surface needs to be drawn in two or more parts which later have to be joined together. Joining two or more elements of a line on surface is done in the following way:



- ↳ Turn on the editing state in the **Layer Control** drop down menu.

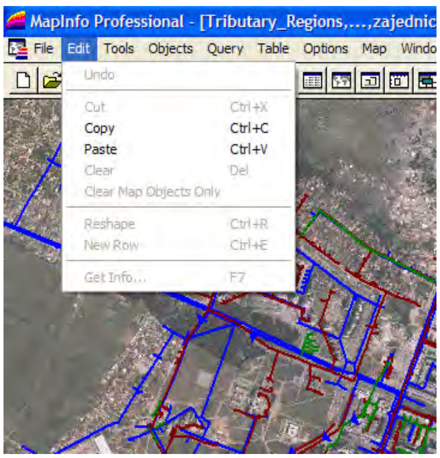
- ↳ Select one element and then select all the elements to be joined by holding down the **Shift** key on the keyboard, and using the left mouse button to select each of the desired elements individually.

- ↳ Use the command **Combine,** from the **Objects** drop down menu and select **OK** in the dialogue box that appears, this will make the elements will join into one.

ONCE LINES OR SURFACES ARE JOINED, THERE IS NO COMMAND TO AUTOMATICALLY SEPARATE THEM AGAIN. ONCE A SELECTION HAS BEEN SAVED AS A COMBINATION, IT WILL STAY IN THAT COMBINATION.

DRAWING NEW OBJECTS ON FILES BY COPYING THE EXISTING OBJECTS

To draw new objects that are identical to ones already in use in an existing file, especially files that are represented by symbols or consist of several lines, you can copy one of the existing object and create an identical new one, then change it's attributes (by clicking the **I** button from the **MAIN** palette). Copying an already existing file can be done by using the following procedure:



↳ Turn on the editing state in the **LAYER CONTROL** dialog box

↳ Using the command **COPY** from the **EDIT** menu (or by holding **CONTROL** and pressing **C** on the keyboard at the same time) temporarily copies all selected objects.

↳ Place the cursor in the new file by clicking the left mouse button where the object is desired.

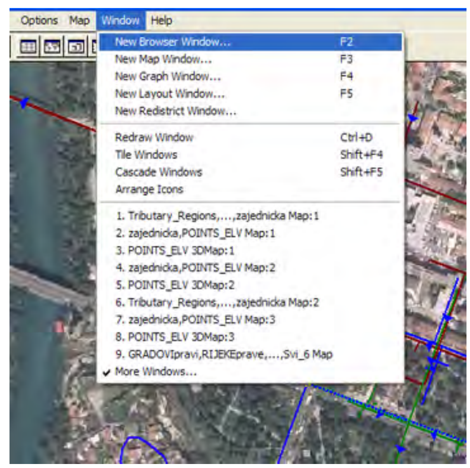
↳ Select **PASTE** from the basic **EDIT** menu (or press and hold **CONTROL** and pressing the **V** button on the keyboard) to place the copied objects as new objects, identical to the copied object in the file. Click the cursor anywhere else on the screen or choose **UNSELECT All** from the **QUERY** drop down menu, the previous selection is canceled and the copied objects can be changed.

↳ If the existing objects are moved to a new place outside the frame of the screen, after clicking **PASTE** the screen will go back to its previous style. In order to see the place where the objects copied, click **PREVIOUS VIEW** on the **MAP** drop down menu, or from the dialogue box which appears when right clicking the cursor.

5. CREATING AND CHANGING CONTENT OF DATABASES ON THE FILES

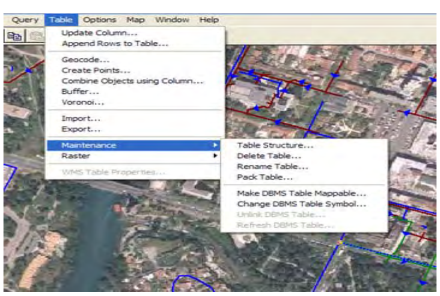
All of the objects on files have one or more “Attributes”. Attributes are pieces of information in the database which have the same name as the file. To view the data for an individual object, activate the information option (**I**) from the **MAIN** palette, and click the cursor over the object.

- ↳ The text font can be changed in the Column by clicking the cursor on one of the cells and pressing the F8 button on the keyboard.
- ↳ Any data in the database can changed, by selecting the data and typing the change.
- ↳ A database for all the objects on a file can be opened by clicking **NEW BROWSER WINDOW** from the **WINDOW** drop down menu or by pressing F2 on the keyboard. If more than one file is open, select the desired database to open in the dialogue box that will appear.



- ↳ Activate the command **TILE WINDOWS** from the **WINDOW** drop down menu in order to split the screen into two windows to view multiple files at once. When selecting any of the objects on the map, it is automatically selected in the database, and vice versa.
- ↳ If the object selected in the database is not visible on the file, it can be found by choosing **FIND SELECTION** from the basic **QUERY** drop down menu.

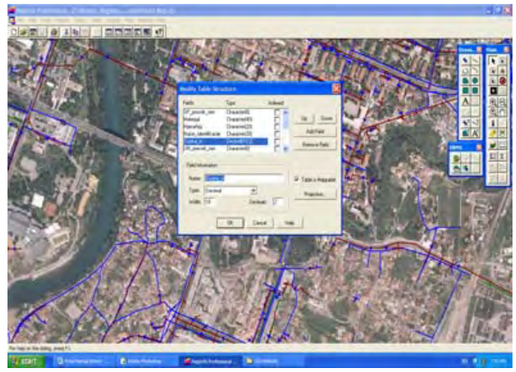
CREATING OR CHANGING THE CONTENT OF DATABASES:



- ↳ From the **TABLE** drop down menu, choose the **MAINTENANCE** submenu and then **COLUMN STRUCTURE**, which opens **VIEW/MODIFY COLUMN STRUCTURE** dialogue box. Then select the file in which the data will be changed.
- ↳ After selecting the file, a **MODIFY COLUMN STRUCTURE** dialogue box appears showing the content of the database, and names and types of data (Character, integer, Decimal, Date etc.).

- Change of name, type and number of characters of some of the data is done in the lower part of the dialogue box, after the data is selected.

- To add a new cell click **ADD FIELD** and a new field is added to the Column. This field needs a name, type and number determined and entered. To change the location of data in a database, press **UP** or **DOWN**.



- To remove data from a database, select the desired field to be removed and click **REMOVE FIELD.**

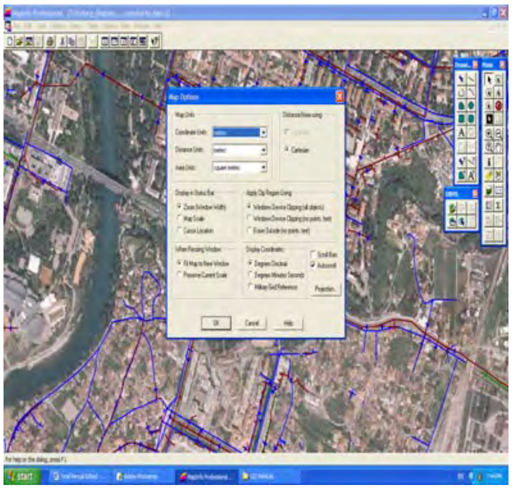
- After the changes have been made and confirmed, the file disappears from the screen. When the database is next opened, the data will appear in the new format.

****VERY IMPORTANT!****

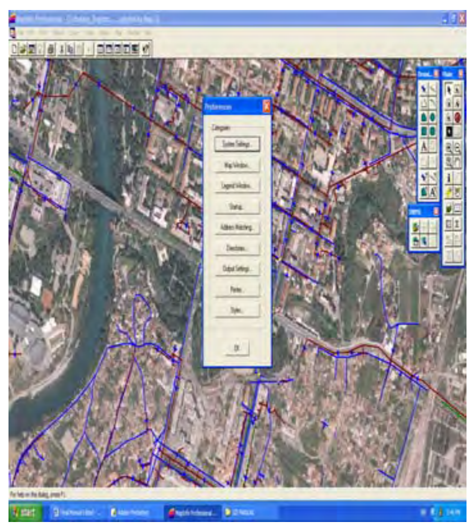
If a file is a part of a combination of files (Workspace) the whole workspace must be open when the data is changed. After the changes have been made you need to open the file again and set its parameters (Layer Control, Display, Display within Zoom Range) and save the workspace again. Otherwise it will not be possible to open that workspace again because the content of some of the files belonging to it has changed.

6. SETTING PARAMETERS

General parameters control the way a map or Workspace is viewed, as well as the user's interaction with the files. General parameters of the screen are set using the **MAP OPTIONS** dialogue box which appears when choosing **OPTIONS** from the **MAP** drop down menu. On the bottom of the screen, where it says **DISPLAY IN STATUS BAR**, the possible options are:



- ☑ **ZOOM (WINDOW WIDTH)** – Window width with specific zoom will be written in the bottom of the screen.
- ☑ **MAP SCALE –** Ratio with specific zoom will be written in the bottom of the
- ☑ **CURSOR LOCATION** - Coordinates of the cursor location in the country's valid system will be written in the bottom of the screen.



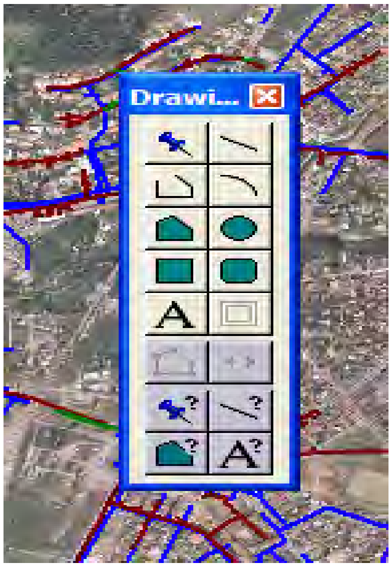
- ↳ By clicking the square that reads **SCROLL BAR,** in the bottom of the same dialogue box, sliders will appear which enable movement of files horizontally and vertically.
- ↳ Click **PREFERENCES** from the main **OPTIONS** drop down menu and select **MAP WINDOW** from the dialogue box. A new dialogue box **MAP WINDOW PREFERENCES** appears**.** In the window that reads **HIGHLIGHT CONTROL,** under the option **SELECTED OBJECTS** set the style of marking by selected objects (lines and surfaces).

SETTING THE PROTECTION ZONE AROUND OBJECTS

It is often necessary to draw protection zones around certain objects. Protection zones are used to protect objects from accidental changes and to create easier selection areas around them. Protection zones are created in the following way:

↳ Put **COSMETIC LAYER** in the state of editing in **LAYER CONTROL** drop down menu.

↳ Select the object to draw the protection zone for.



↳ On the **DRAWING** icon menu, click the button for **SURFACE STYLE** and choose the style for the protection zone. Pattern-less is recommended (**PATTERN - NONE**).

↳ From the basic **OBJECTS** drop down menu, choose **BUFFER** and a dialogue window which reads **BUFFER OBJECTS** appears. Click **VALUE** and set the width of the protection zone. After confirming on **OK**, the defined buffer will be in the temporary layer.

↳ The command **SAVE COSMETIC OBJECTS** from the basic **MAP** menu saves the protection zone on the file or layer on which it is formed.

↳ The command **CLEAR COSMETIC OBJECTS** from the same menu permanently deletes the buffer.

7. ADDING A NEW COLUMN OR A NEW PIECE OF DATA TO A DATABASE

With MapInfo software it is possible to add new data to the content of a previously existing database from within the program, instead of changing the database independently of the software. New data added to the content of a database of a file can be one of the following:

- Data added directly to the database
- The result of a formula involving data from the Column (for example, new data C = existing data A + existing data B).

PROCEDURE FOR DATA ADDED DIRECTLY TO THE SAME DATABASE:

The procedure described in the Section 5, forms a new column in a database on objects in the file (Column).

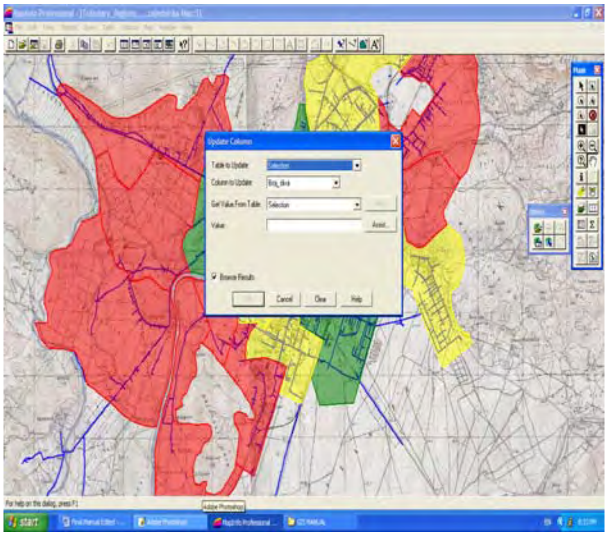
VERY IMPORTANT!

If a file is a part of a combination of files (Workspace), changes should be made while the ENTIRE Workspace is open. After the changes have been made it is NECESSARY to open the file again and reset its parameters (Layer Control, Display, Display within Zoom Range) and save it in the Workspace again. Otherwise it will not be possible to open that Workspace again, due to the content change of one of the files included in the Workspace.

↳ Click the **Update Column** option from the **Table** drop down menu. This opens the **UPDATE COLUMN** dialogue box.

↳ Click **COLUMN TO UPDATE** to choose the file for which you are deriving the new piece of data (in the example, it is the file connected to the database to which the new column was added).

↳ Select the added column in **COLUMN TO UPDATE** option.



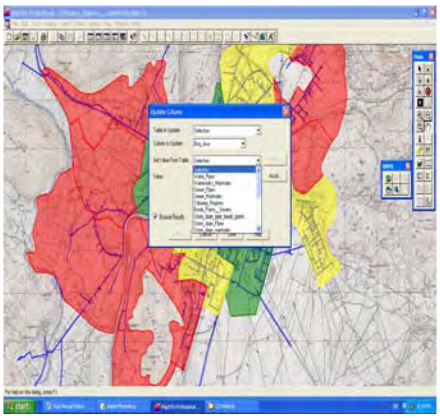
↳ Activating the command **ASSIST** in the same dialogue box.

↳ This opens the **EXPRESSION** dialogue box where a formula should be created, made from the existing columns (this formula must respect the database hierarchy) and mathematical and logical **OPERATORS** or **FUNCTIONS**.

↳ After checking with the command **VERIFY** to confirm that the formula is correct. After that click **OK**.

↳ The **UPDATE COLUMN** dialogue box will appear again, which requires confirmation of the procedure once more by clicking **OK.** The result of the new formula will be shown for every object in a new column.

DATA TAKEN FROM MATHEMATICAL CALCULATIONS OF COLUMNS WITHIN THE DATABASE:



↳ Open the table from which you wish to make calculations the from.

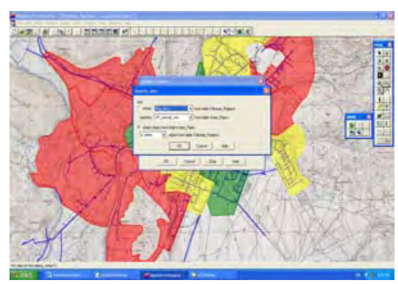
↳ Choose **UPDATE COLUMN** from the **COLUMN** drop down menu.

↳ Select the file to update from the **UPDATE COLUMN** dialogue box in **COLUMN TO UPDATE** option.

↳ In **COLUMN TO UPDATE** field select the column to update.

↳ In field **GET VALUE FROM COLUMN** choose the file from which to take the changed data (**TS_DISP** in this example).

↳ In **CALCULATE FIELD**, keep the option **VALUE**, because other parameters can be calculated as well.



↳ Choose the column from which data is taken in the field **OF** and click **JOIN**.

↳ In the **SPECIFY JOIN** dialogue box define the same piece of data as the link for both Columns. Click **OK** to confirm.

↳ In **UPDATE COLUMN** dialogue box which reappears, confirm all options by clicking **OK** and the changes are completed.

↳ If the changes were made in more columns of the original file or column, repeat the procedure for all files and save the changes.

↳ Save the changes made to the database

8. SEARCHES AND QUERIES

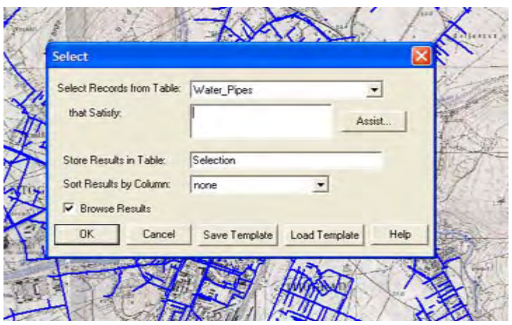
A very important function of GIS is the ability to perform various searches, calculations and queries when analyzing files in GIS (i.e. objects on the files). Queries can include analysis of alpha-numerical data on the objects in a file or spatial-geographic analysis of objects or both of these types of analyses in combination. Searches and queries can be done in the following two formats:

☑ Using **SELECT** from the basic **QUERY** menu

☑ Using **SQL SELECT** from the basic **QUERY** menu

SEARCHES PERFORMED BY USING SELECT

↳ Choose **SELECT** from the **QUERY** drop down menu. This will open the **SELECT** dialogue box.



↳ From **SELECT RECORDS FROM COLUMN,** choose the file in which you want to perform the search.

↳ In the field **THAT SATISFY,** write the condition that objects should satisfy, or criteria for the search. This task is made easier by using the command **ASSIST,** which activates **EXPRESSION** dialogue box.

↳ Use the **EXPRESSION** dialogue box to create the formula (out of the columns and operators or functions) which will define the condition search objects should satisfy.

↳ Use **Verify** to check whether the formula is correctly written.

***Note: Data fields must always be in quotation marks in formulas**.*

↳ In the **SELECT** dialogue box which will reappear after verification of the formula, define the name of the selection made (if you keep the **SELECTION** option the file of the selected objects will be called **QUERY**) and the column according to which the Column of results will be sorted.

↳ If the **BROWSE RESULTS** option is activated, the result of the query will be shown in a Column and the objects will be marked independently in the file.

↳ If the **BROWSE RESULTS** option is turned off, only the objects will be marked in the file.

- If the selected objects (i.e. the objects that satisfy the condition) are not visible on the screen after the confirmation, click **Find Selection** from the main **Query** drop down menu.

- To cancel the selection, click **Unselect All** from the **Query** drop down menu.

- To save the file, use the **Save As** command from the **File** drop down menu.

Searches performed by using SQL Select

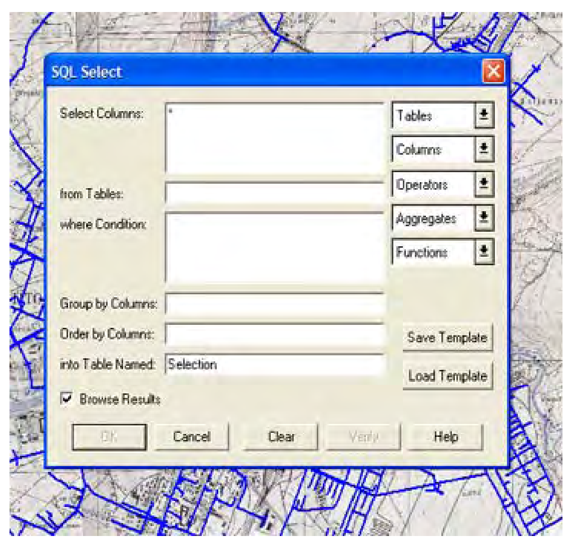
The possibilities of searches, queries and various calculations when performing analyses are much bigger using this command compared to the previous one. This way you can analyze object by using their relations to other objects from other files or databases. It is possible to form new files with objects from one file and a database extended with data from another file or database. Using the command **SQL Select** you can perform various mathematical operations, table grouping etc. To perform an **SQL Search,** use the following procedure:

- Choose **SQL Select** from the **Query** drop down menu. This opens the **SQL Select** dialogue box.

- If there is a previously performed query in the dialogue box, delete it using the **Clear** command from the bottom of the window.

- In the field **From Tables** in the dialogue box, use the **Tables** sliders on the right to select the file you want to search.

- Leave the selection star in the field **Select Columns** to see the whole table (all columns) in the result of the search. If all of the data in the results is not desired, click the star in the **Select Columns** field to remove it. Using the **Columns** sliders on the right chooses and adds the columns desired the results.



- Move the cursor to the **where Condition** field and use the slider on the right to create the formula out of columns and operators of functions. This defines the condition that needs to be satisfied.

  ***Note: Data in characters have to be contained in quotation marks in the formula. ***

↳ In the field **INTO TABLE NAMED** define the name under which the selection will be created (by keeping the offered option **SELECTION**, the picture of the selected objects will be named **QUERY**).

↳ In the field **ORDER BY COLUMNS,** define according to column how the table of results should be sorted.

↳ If the **BROWSE RESULTS** option is active, the results of the search will be shown in a table and the objects will be marked in the picture. The results of the search will be shown only in the picture (the objects will be marked) if this option is turned off.

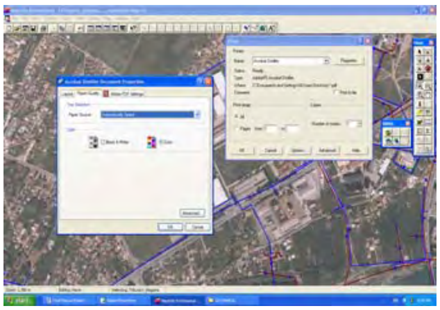
↳ If the objects which satisfy the established condition are not visible after confirming on **OK**, they can be found by using the command **FIND SELECTION** from the **QUERY** menu.

↳ To remove the selection or to unmark all objects click **UNSELECT ALL** from the **QUERY** drop down menu.

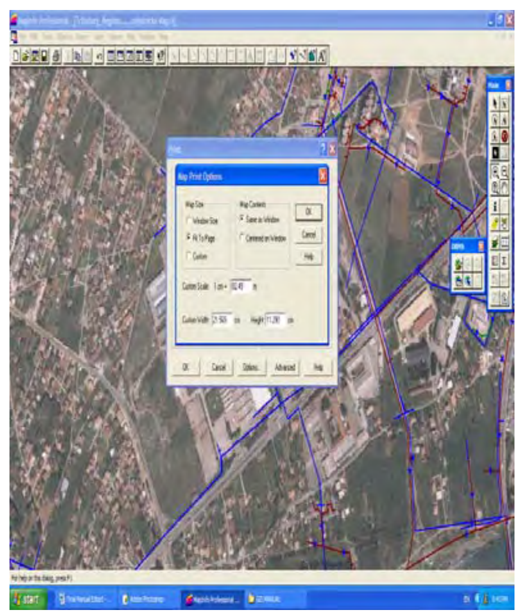
↳ To save the query as a separate file, select **SAVE AS** from the **FILE** drop down menu.

9. PRINTING PICTURES AND TABLES

Another advantage to GIS programs is the ability to print large area maps and view them in a large format. The printable size of maps is limited only to the size of paper and the printer available to the organization. To print pictures and tables use **PRINT** from the **FILE** drop down menu. To set up the printing parameters for paper size and orientation, use **PAGE SETUP** from the **FILE** drop down menu. Printing is done with the following method:



- ↳ Choose **PRINT** from the **FILE** drop down menu and the **PRINT** dialogue box will disappear.
- ↳ In the **Print** dialogue box, click **PROPERTIES** to set up the printing parameters related to the type of the printer.
- ↳ Choosing **OPTIONS** from the **PRINT** dialogue box while the file is on the screen, this automatically opens the **MAP PRINT OPTIONS** dialogue window and the **BROWSER PRINT OPTIONS** dialogue window if a table is on the screen.

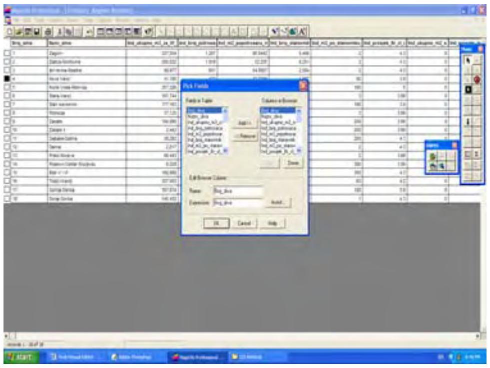


- ↳ By choosing **CENTERED ON WINDOW** in the **MAP PRINT OPTIONS** dialogue box in the **MAP CONTENTS** menu**,** the picture will be printed in the current ratio cropped to fit an A4 sheet. If you choose the **SAME AS WINDOW** option, the picture will be printed in the current ratio in a part of an A4 sheet.
- ↳ To print the picture in another ratio choose **CUSTOM** in the **MAP SIZE** part and set the ratio you want in the **CUSTOM SCALE** field.
- ↳ Click **OK** to confirm the action in the **MAP PRINT OPTIONS** dialogue box, and the same in the **PRINT** dialogue box and the printing will start.
- ↳ The **BROWSER PRINT OPTIONS** dialogue box gives options for the printing of the entire database or only certain columns.
- ↳ Click **OK** in the **BROWSER PRINT OPTIONS** dialogue box and same in the **PRINT** dialogue box and the printing will start.

CHANGING DATABASE APPEARANCE FOR PRINTING:

↳ Open the database you wish to print in the map window.

↳ Right click the database and a drop down menu will appear. Select **PICK FIELDS**.



↳ In the **PICK FIELDS** drop down menu a window will appear, showing the columns in the original table on the left side and the columns that will print on the right.

↳ Use **ADD** and **REMOVE** to choose which columns should print. Use the **UP** and **DOWN** commands to set the order in which they will print.

↳ Define and add new columns which are combinations of the existing ones defined with the **EXPRESSION** command.

↳ Adding a new column with the **EXPRESSION** command to the table you want to be printed will automatically open the **EXPRESSION** dialogue box where the desired expression can be created.

↳ After confirming the action by clicking **OK**. The database which will be printed with a new column which is formed with the expression, and can be viewed in the bottom part of the **PICK FIELDS** dialogue box, in the **EDIT BROWSER COLUMN** field.

↳ Change the names of columns for printing and even the content of the tables by using the **ASSIST** command.

* **Note:** The table ready for printing is temporary and is not saved after closing. Only the original table stays saved.